The
Geographical Journal.

No. 3. MARCH, 1914. Vol. XLIII.

RELIEF IN CARTOGRAPHY.*

By Captain H. G. LYONS, D.Sc., F.R.S.

An accurate and adequate representation of the Earth's surface is of the utmost importance to the geographer, and it is to be regretted that, in this country at least, he does not devote more attention to this important branch of geography. Cartography is largely left to the draughtsman, the engraver, and the printer, and while each of these have their own ideals of high-class work, it does not follow that the realization of these ideals will certainly produce the best possible map from the geographer's point of view. Maps are intended to be, so far as the scale will admit, mathematically correct reproductions of the Earth's surface, so that accuracy of delineation is of first importance, especially if they are to be used for technical work; but a forcible representation of its relief has a definite value, and is of great assistance in reading the map. In its well-developed form, the expedient of inclined illumination may give better results in wall-maps and general maps than in special or detail maps which are on the larger scales; contours alone, even when used in connection with hachures or brush-shading in vertical or inclined light, do not always show the relief of large masses sufficiently strongly, so that colours have been employed in order to represent the third dimension more effectually.

The aim of the cartographer is to represent as accurately as possible every point of the earth's surface on his map, and while two-dimensional representation of the spheroidal surface offers certain difficulties and necessitates the adoption of certain conventions, it is the third dimension of its features, the relief, which provides problems that tax his ingenuity to the utmost as he attempts their solution.

Hachures, contours, shading, bands of colour, each represent a class of work which has at one time or another been predominantly used, but while

* Royal Geographical Society, November 20, 1913.

each has its special merits, each has also its limitations as to the scale on which it can be effectively used, the information which it gives, and the degree to which it affords to the eye a picture of the uneven surface which it is desired to represent. No one method is satisfactory under every condition, but the most suitable to the case in question has to be selected.

The increasing demand for maps of greater completeness and accuracy in all parts of the world, the vast importance of relief in all geographical investigations, the new problems raised by aviation, have all increased in recent years the need for the utmost efficiency in the representation of relief on maps of every scale, and consequently a large amount of study has in recent years been devoted to this subject, more particularly on the Continent, as the yearly bibliographies of the subject show. About twenty-five years ago the Royal Geographical Society appointed a Committee to study the subject of school wall-maps, and in their recommendations the representation of relief is touched upon, but not in a detailed manner.

Apart from other geographical data, such as rivers, coast-lines, and all the signs of man's occupation, the cartographer must show information of three distinct types when he deals with the third dimension of land features.

Firstly, the height of any point above some reference datum is required in terms of some unit of length; secondly, the higher portions must be distinguished from those which are situated at a lower level; thirdly, form of each feature as it has been moulded by the erosive agencies which have acted upon it must clearly be brought out. The difficulties of doing this are neither few nor small, and an important one may be found in the very great disproportion which exists between the vertical and horizontal dimensions of the physical features of the earth. The highest mountain rises to 8840 metres above sea-level, and the deepest ocean abyss descends to about 9700 metres below it, the total range in the surface relief thus amounting to about 18,500 metres. But if this be compared with the equatorial circumference of the Earth, amounting to 40,000 kilometres, the ratio is but 1 : 2135. If any line on the Earth's surface be taken, and the horizontal distances as well as the heights and depths of the physical features on it be plotted to the same scale, we shall obtain a more or less exact representation of the Earth's surface along this line according as the number of points selected is greater or less, and from it we may gain an idea of the relation between the horizontal and vertical dimensions. But even where large features are concerned their vertical dimensions are of small significance as compared with the horizontal distances involved.

But while the elevations of the Earth's surface are so insignificant as compared with the distances which separate them on it, they present an imposing appearance as seen by us, since the angle subtended by them at the eye is many times greater than that subtended by the horizontal distance which separates them from us. Consequently an exact representation

of the vertical dimension drawn in a section to true scale must give the impression that the surface is far less irregular than it appears to us to be. The map, on the other hand, represents a landscape as though it were seen from above, so that hill and valley no longer stand out clearly, and changes of slope are not recognizable; consequently careful and accurate cartographical expression must give the impression of extreme flatness and monotony of surface as compared with the reality as seen with the eye, unless special means are adopted to emphasize its shape. If, therefore, we are to obtain the effect which we are accustomed to associate with hills and mountains, the relief must be exaggerated and the faithful reproduction of nature must thereby be sacrificed to some extent, although strict accuracy in the vertical dimension should be the aim of the cartographer when he is dealing with relief just as much as when plotting the detail of a two-dimensional map.

Various methods may be employed for such expression of land relief, and their treatment of the data may be either mathematical or optical. In the former the altitudes of numerous points above a certain reference surface are stated numerically, so that the efficiency of such a method is dependent on the number of points so determined and the accuracy of the determinations; in the latter method the form of the surface is reproduced by various arrangements of black, white, and colour, whereby the slope is more or less definitely indicated, and also the relative altitudes to some extent, but the absolute altitudes above a datum line or surface are not directly ascertainable.

No one system satisfactorily furnishes both of these classes of information, and the various devices which are employed for representing relief may be considered as attempts to indicate more or less successfully either the relative altitudes of different parts of a region, or to compare the different slopes of its surface. The different methods in which these aims are attained with greater or less success may be conveniently grouped in three classes. The first of these employs the mathematical method, and includes contours and horizontal form-lines, as well as that further development in which the intervals between contours are occupied by bands of graduated colour, the so-called "layer system." The second method is that of hachures, in which vertical lines of black or colour drawn in the direction of steepest slope at each point, and therefore perpendicular to contour-lines, are employed These hachures indicate the slope, but cannot record the absolute altitude of any point, though the higher and lower portions of a slope are usually recognizable. The third group contains a large number of devices, all of which depend on the use of colour to bring out the alternate effect of light and shade which we see where an uneven surface, such as a mountainous region, is illuminated by rays of light falling on it, not vertically, but making a considerable angle with the vertical. By darkening the portions which would be in shade, or by employing contrasts of colour which attain a similar result, the relief effect

may be strikingly brought out, but neither are altitudes precisely indicated nor are slopes truly represented.

All these methods have their advantages and their disadvantages, and preference must be given to the method which best meets the requirements of the particular map under consideration. Hachures were at one time almost exclusively employed, and under certain conditions are most satisfactory; the accumulation of large masses of reliable material when accurate levelling had been carried out over large areas led to a much freer use of contours; of later years the demand for a more effective expression of relief than contours afford has led to the development and wide employment of methods in which colour is largely used to produce that relief effect which contours do not supply.

Contours.—In the first place, when drawn upon a map, contours enable the general form of a surface which is defined by a number of determined altitudes to be rapidly appreciated, indicating not only the general slope of the surface, but also its numerous inequalities and discontinuities so far as these are shown by the determinations of altitude. They show the general form of the ground and also emphasize certain types of feature, for peaks are indicated by concentric circles, ridges by elongated ovals, and valleys and spurs by bends in the general direction of the lines, while steep slopes are strongly contrasted with level country. The direction perpendicular to the contours being that of greatest slope, one of the most important properties of contours is that the distance along such a direction gives the average slope of the ground. There is, however, a limit to this form of representation in spite of its mathematical accuracy, since there will be for any given scale and any given vertical interval a slope for which it is impossible to indicate the contour-lines, since the line employed on the map has an appreciable breadth. If we take the case of contour-lines each 0·15 mm. broad, drawn to represent vertical intervals of 30 metres on a map on the scale of 1 : 50,000, as soon as the horizontal distance between such lines of equal altitudes becomes but 7·5 metres the contour-lines on the map will be touching, and such vertical interval and horizontal distance will correspond to a slope of $\frac{4}{1}$ or 76°; where smaller scales are employed the vertical interval is represented by a smaller actual length, and as the contour-line cannot practically be reduced below a certain width, the limiting slope which can be represented becomes rapidly less. On the international map on the scale of 1 : 1,000,000 the vertical interval is 100 metres, and if the contour-line is taken at 0·1 mm. broad, which represents 100 metres on this scale, it will be seen that the greatest slope which can be shown will be but 45°. Finer lines can be produced but contours are preferably printed in colour, and so must be of a moderate strength in order to be read easily.

But since extreme slopes do not frequently occur in nature, contours are usefully employed to reproduce the forms of the ground; relative

altitude is expressed by them most effectively and the positions of points in any part of the map are referred to a horizontal plane, and may be directly compared. Slope is less effectively rendered, and a trained eye is needed to estimate quickly and correctly the angle of inclination which the contours express. Their effect is at its best where there is a strong contrast, and the steep walls of ravines can be compared effectively with plateau surfaces above them. The result is that altitudes of any points are easily measurable, but training is required to appreciate readily the relief of the ground, to translate the lines of equal height into the various slopes and to recognize the innumerable forms that ground presents; where the steeper slopes occur, the closely packed contours approximate to a class of shading which, though it hardly gives that which can be called a relief effect, emphasizes the steeper declivities and thus facilitates the reading of the surface forms. In lower or less diversified landscapes they are not so satisfactory, and gently undulating ground may be very ineffectively represented unless some additional means of differentiating the slopes is employed.

Accurate contouring requires that a very large number of points shall have their altitudes known with considerable precision in order that the contour-lines shall be correctly drawn, and this is a lengthy and expensive operation. From a few points the expert topographer may represent very fairly the general shape of the ground, but the precision will be low; with numerous points the uncertainty becomes less, but a certain amount of interpolation is unavoidable. The accuracy of a contoured map is not therefore determinable from the map itself, and where systematic spirit-levelling has not been carried out over the whole area, but the results of approximate methods have been utilized, the precise expression of contours is misleading, since they may be understood to indicate a much higher accuracy than the position of the lines can claim. The impression of relief which the expert geographer receives from a well-contoured map is not due to the contour-lines as they are drawn, but rather to the unconscious translation of them into the expression of form by the trained mind; the curves, loops, and other forms which the contour-lines assume are associated in his mind with certain forms of ground, and consequently he seems to see a relief effect when they are employed.

As the scale of the map decreases not only does the vertical interval represented increase, but the form of the surface as shown by sinuosities of the contours loses much of its detailed expression as the minor curves of these lines have to be generalized. Then the contours only show the larger features, and these may be much obscured by the accumulation of detail relating to the human occupation of the region, for this spreads a network of black lines, signs and dots over the face of the map, which has its density increased both by condensation of its material, and by the necessary exaggeration of the conventional signs employed.

In countries where the surveys are of the reconnaissance type and consist of a large amount of approximate work controlled by comparatively few points which have been accurately determined, the relief cannot be represented by contours, since the data do not suffice to lay down lines of equal altitude on the map. Here an inferior precision in representation must be admitted, though an attempt has been made to retain the mathematical basis to a limited extent by drawing form-lines approximating to contours, but at no definitely determined altitudes or intervals; the interval between each pair represents a difference of interval which does not vary very greatly perhaps from a mean value, but no accuracy is reached in this respect, and the interval may vary in different parts of the map. The object is to obtain the best representation of the relief possible with the limited time and material available, and the method is usually employed by a topographer who is restricted in these respects by military or other conditions. There are usually very few points of which the heights are accurately known, so that the representation obtained by the form-lines gives the relative importance of neighbouring hills and features rather than any attempt to indicate the altitudes of different points. But even with these limitations, it is a very useful form of hill drawing, and in neat and practised hands gives extremely satisfactory results if the topographer has a good knowledge of earth-forms.

The form-lines in maps on the smaller scales tend to be drawn more boldly on the spurs than in the re-entrant valleys where the lines are crowded, and this gives the appearance of deeply dissected features where none exist. At one time these form-lines were usually interrupted, thereby drawing attention to the fact that they had not the value of normal contours, but of late years continuous lines have been used which are indistinguishable from levelled contours, and only a note in the imprint calls attention to their tentative character; even this warning is sometimes omitted.*

Contours thus provide the most precise method of expressing relief; they express altitude and slope until the angle of inclination is considerable, and this limiting angle decreases as the scale of the map becomes smaller. They are most effective in topographical maps of fairly large scale, *e.g.* 1 : 10,000 to 1 : 100,000, but beyond this point they begin to suffer from the necessary smoothing of the smaller curves, and also because the intervals between them must be increased. This is especially the case in mountain regions where slopes are steep, and consequently their horizontal projection is short, so that the interval between contours has to be even further increased, and for scales of 1 : 1,000,000 and upwards contours must be but a conventional representation of ground form. From their character of a thin line, now usually in colour, they are much obscured wherever much detail has to be shown,

* Cf. South Africa, 1 : 250,000, War Office; 'Mitt. aus. den deutsch. Schutzgebieten,' Ergh. 4, 1911; and many others.

which will be the case in fertile and populous areas, and on maps of small scale in which information is greatly condensed.

The Swiss maps of the Siegfried Atlas, scale 1 : 50,000, furnish excellent examples of contours on mountainous country, while in the maps of the United States Geological Survey, scales 1 : 62,500, 1 : 125,000, and 1 : 250,000 examples may be found on several scales and of every imaginable type of country.*

Relief is not therefore satisfactorily expressed by contours in all the cases that may arise, and fair aptitude in reading them is necessary if full use is to be made of the information they present. Many schemes of colour have therefore been devised for the better representation of relief in cases where contours alone have proved inadequate, but only a few can be alluded to here. In the selection of colours for such methods, considerable care is needed, and the general requirements were summarized as follows by von Hauslab :—†

(1) In spite of differences of colour, there should be a general impression of a definite graduation of tint ;

(2) The colours employed should be distinct and readily distinguishable ;

(3) The colours, though different, should harmonize ;

(4) The main forms of relief, the higher and lower areas, and the height of any point should be readily ascertainable.

All these requirements cannot be fully satisfied in a single scheme of colour, so that additional means have to be adopted in order to indicate the varying slopes or to accentuate the higher or more important features ; for this purpose hachuring, strengthening of selected contours, shading, colours, etc., are employed.

The introduction of the use of colours for the better representation of relief dates from about a century ago ‡ when von Hauslab in 1830 indicated differences of relief in a map of Turkey by graduated bands of colour. Following the idea which underlay Lehmann's system of hachuring, he used the darker tints for the higher zones, and justified this choice on the ground that the far greater development of human occupation at the lower levels made it especially convenient to use the lighter tints there in order that the legibility of these portions should not be impaired. He adopted the same principle when employing a more complete scale of colour, which started with white for the lowest levels and then ranged through yellow, bright-red, red-brown, olive-green, green, blue-green and violet to purple in the highest zones.

Very good results were also obtained by Leutzinger, who followed the reverse arrangement, reserving the lighter tints for the higher levels, and,

---

* Professional Paper No. 60 is especially convenient for reference.

† R. von Hauslab, 'Ueber die graphischen Auffuhrungsmethoden von Hohenschichtenkarten,' *Mitt. k.k. geog. Gesell.* Wien, 1864.

‡ K. Peucker, 'Schattenplastik und Farbenplastik,' p. 10. Wien, 1898.

starting with a transparent green-grey in the lower ground, passed through greenish-brown and yellowish shades to white.

A modified scheme was introduced by E. von Sydow,* who used green, white, and brown in his maps in order to differentiate low land, higher land, and mountains, wherein he was employing the colours of green, white, and brown respectively for these regions. But this method only defines relief in a general manner, for it is not necessarily combined with a strictly hypsometrically constructed basis, and requires to be supplemented by a complete system of hachuring or shading as well if it is to indicate hill ranges or plateau margins adequately. It is best suited for wall-maps and school-maps, to which its use is mainly confined,† and in which it is very effective.

Such bands of graduated tints may be restricted to shades of a single colour as in von Hauslab's original maps, or in the bathymetrical charts of the ocean basins, or in Bartholomew's maps of the Scotch lakes, where brown is used in light tints for the low ground, and in shades of successively increasing intensity for the higher levels, while the blue becomes deeper in shade as the lake depths increase. Such an arrangement only provides a limited range of zones, since contiguous bands must be distinguishable, and the highest and therefore darkest portions must not obscure any writing or detail that there may be; the cartographer therefore is often compelled to employ several colours in his scheme, and choice of these is a matter of some importance. So far as special conditions do not limit our choice, as in the case where both custom and natural colour determine that blue shall be used for water surfaces, physiological optics should largely guide us in ascertaining what will be the most favourable combination of colours to produce the effect of relief for which we are presumably striving. Some of those who have indicated relief by means of colour have proceeded on quite a different line, and have employed contrasts of colour in which simple and mixed colours, or half-tone and solid colours, or light and dark, or a colour and its complementary colour have been used; then there is no gradual passage by graded tints, but sharp contrasts corresponding with certain altitudes are aimed at. In such maps, the same colour may be repeated at different levels if no ambiguity is caused.

But whatever system be adopted the cartographer's results have to be received through the eyes of the geographer, and the teaching of physiological optics should therefore be the guide to the selection of colours to be used in cartography. To the majority of persons, when blue and red patches of colour are juxtaposed on a plane surface, the red appears to stand out from and the blue to fall behind the plane surface. The explanation of this ‡ is to be sought in the asymmetry of the eye, of which the

* 'Methodischer Altas für das wissenschaftliche Studium der Erdkunde,' 1842.

† Sydow-Wagner, 'Methodischer Schulatlas'; and Sydow-Habenicht, 'Methodische Wandatlas.' Gotha: J. Perthes. 1912.

‡ "Zur Frage der Farbenplastik in der Kartographie," by Dr. E. Bruckner and Dr. A. Bruckner, *Mitt. k.k. Geogr. Gesell.*, p. 186. Wien, 1909.

line of vision and the optical axis do not coincide. When a blue object is focussed upon the retina red rays from a neighbouring object will be in focus behind the retina and on it will form a circle of which the centre is displaced outwards, *i.e.* away from the nose, from the focus of the blue rays. Conversely, when the eye is focussed for red rays, the centre of the circle formed by the blue rays, which are brought to a focus in front of the retina, is displaced inwards from the focus of the red rays. Such displacement inwards or outwards corresponds respectively to that which takes place when remoter or nearer objects are viewed, so that the blue object appears to be further off while the red is advanced. This fact is utilized to produce an apparent effect of relief by employing colours from the red end of the spectrum for higher ground, and using the more strongly refracted ones for lower areas.

Very bright colours produce the effect of nearness, so that it is not only desirable that the colours indicating relief should be graded in the order of their refrangibility, red to violet, from the high to the lower ground, but that they should also diminish in intensity. In such a theoretical arrangement the violet should, of course, be the pure spectral colour, and not the usual mixture of red and blue. Oceans, seas and lakes are conventionally blue, so that a bluish-green or a dull green is theoretically the most suitable colour for the low ground, and thence avoiding the bright yellow, the colour-scheme rises through yellowish-green to buff-brown, reddish-brown to even red, white and bluish-white being reserved for the snowfields and glaciers. In the natural colour scheme of von Sydow, a white layer was used between the green and the brown, but it gives an effect of discontinuity when introduced into a completely graded scheme of colours.

The ways in which colours may be used with contour-lines are extremely diverse. In the simplest form, narrow bands of coloured shading are carried along the contour or form-lines as has been done in the map of the Albert and Edward lakes in central Africa by Max Moisel,* and other maps by the same cartographer.† The effect is clear and steep slopes are well brought out, but it gives a strongly terraced character to the landscape which can rarely be in accordance with nature. The Ruwenzori hill mass in the map just quoted is a good instance of the weakness of this treatment.

Mr. A. R. Hinks has proposed to use strong lines of colour for the contours as an aid to reading the relief. It would presumably only be applied to large-scale maps, and its especial advantages are not quite clear. It is the extreme case of contrast colouring, and has the objection that the altitude corresponding to each colour has to be borne in mind, which seems less convenient than employing the requisite numerals.

The use of strongly contrasted colours to indicate different zones of

* *Mitt. der Geogr. Gesell.*, 17, K. Ia. Hamburg, 1901.

† Cf. *Mitteilungen aus den deutschen Schutzgebieten* in recent years.

altitude was early introduced, Gylden's map of Finland, scale 1:1,120,000, 1850, being one of the earliest; blue, green, brown, red, yellow, and white made a simple and strongly contrasted scheme. Harm's wall-map of Germany, 1901, repeated colours twice and in the case of white three times in its scheme at first, and is consequently not to be recommended as an example to be followed; but the method is very well exemplified by the sheets of the map of Bavaria, published by the Government Survey Office on the scale of 1 : 250,000 from 1872 to 1905, when it was superseded by the present map with graded colouring. The lowest land was coloured a light grey-green, and the scheme rose through yellow, dark yellow, pink, light grey, green, dark grey, violet and carmine to light blue. The colouring was distinctive, but the numerous contrasted colours do not bring out the land-forms well.

In the aeronautical map proposed by Gasser,* a distinctive colour contrast scheme is proposed for zones from 0 to 500 metres, the same colours being repeated for the next 500-metre zones. Such grouping of colours may be useful when certain zones have to be strongly emphasized, but otherwise they are less convenient than a gradation from colour to colour in which the next higher or lower zones are at once distinguishable. It finds its most suitable employment in geological maps where contrast is desired in order to distinguish between rocks of different age or character. When subdivisions of a formation have to be indicated, graded shades of one colour may be used, but at the cost of the contrast effect.

Except where special considerations demand colour contrast, the present tendency is to follow the spectral grouping by selecting colours in the order of their refrangibility, and while some schemes have produced a satisfactory relief effect in this way, the failures in other cases where the principle has been departed from in the higher zones is not less instructive. The maps of the British Isles on the scale of 1 : 126,720, published by J. Bartholomew & Son of Edinburgh, are well known, and in the grading from green through yellow to light and successively darker and redder browns, a good spectral arrangement of colours is provided which expresses a definite relief effect. A somewhat similar scheme was introduced by the Ordnance Survey for maps on the same scale, but here shading was added to increase the relief effect, and does so at the cost of obscuring the detail on the steeper slopes. A more serious objection, however, was the use of solid or nearly solid shades of a dark neutral tint for the highest zones, a colour so far removed in its refrangibility from the red-browns, that the hilltops so coloured and standing as isolated areas in the red-brown appear to recede from these and give rise to the effect of depressions occupying the hilltops and ridges.† In a

* *Pet. Mitt.*, 1909, pl. 35.

† See some of the sheets of this map of North Wales and Cumberland, but in the atest edition this defect has been remedied.

certain atlas map of the Alps, a very well-marked relief effect up to the dark red-brown bands has been completely neutralized by the printing of a violet tint above them for the highest zones. But there are other maps in which a spectral grouping has been more completely carried out, and a recent map of the Bavarian Government on the scale of 1 : 250,000 which replaces an earlier edition with the colour contrast scheme described above, carries the brown tints up into a darkish-red with very good effect, though unfortunately the detail of the published sheets ends at the political boundary just where the higher mountains begin to appear, so that the method is not as fully represented as might be the case.

In the international 1 : 1,000,000 map, the higher zones are coloured carmine rather than in shades of red, a departure which I am inclined to regret; the grading of tints from light to dark as the height increases is also not uniformly followed, since in the low levels, from 0 to 300 metres, and the highest levels, from 2500 to 7000 metres, the reverse grading is employed, leaving the middle region of the scale, from 300 to 2500 metres, to follow the more ordinary rule of "the higher the darker." Certainly the whole series will rarely if ever appear on one sheet, and the highest members will not often be used, but it would be interesting to know the reasons for the selection of this particular scheme of colours, and of their arrangement.

A very striking example of the spectral colour scheme carried as far as possible towards its logical conclusions has been furnished by Dr. K. Peucker,* in his endeavours to provide the most suitable representation for aeronautical maps; he has published a portion of the Alps to the south-east of Botzen on the scale of 1 : 200,000, showing a range of heights from 0 to 4000 metres, as well as a sheet including the upper valley of the Po and the Southern Alps.† The principal contour-lines are somewhat strongly drawn in, and shading with light falling from the south is added to increase the relief effect, which is given by colouring the lowest 250 metres grey, and thence passing upward through shades of green, yellow, and orange to a bright red for heights above 3000 metres.

Since the relief effect is obtained by the comparison of colours which are arranged in order of their degrees of refrangibility, the best effects will be produced when a considerable portion of the scheme can be shown in a single map sheet; hence it is particularly suitable for hilly country and for moderately small scales. Since the colour band must be several millimetres wide in order to be effective, the vertical interval on small-scale maps which are orographically coloured must be considerable. On maps of large scale, or where differences of relief are small, this relief effect cannot well be obtained, for large portions of a sheet will be of a single tint or one or two tints which are closely related. Here the gain is rather in rapidity of reading the map, since the approximate

* "Hohenschichten-Karten," *Zeitschrift für Vermessungswesen*, p. 17. 1911.

† Published in Milan, 1910.

altitude can be at once recognized, and lower and higher portions are clearly indicated. The criticism * which has been passed on the use of regional colours, viz. that a sheet which is coloured mostly green may be misunderstood to represent a more fertile country than one which, being situated at some 600 metres greater altitude, is coloured with a shade of brown, is not a very damaging one in these days when almost every school map is coloured orographically, and von Sydow's regional colours of green and brown separated by white or yellow or some variation on these are almost universally employed in schools.

When we come to consider the maps on the smaller scales in which considerable generalization and elimination of detail takes place, the location of the high masses in a region is of greater importance, both practically and geographically, than the accurate delineation of their slopes, and for this colour schemes are particularly well adapted. Here the colours should be readily distinguishable, and rather strong on account of the black detail which is usually dense.

Wall-maps for the use of schools which have to show the surface forms so as to bring out the main hill masses, the plateaus and the low grounds, employ, as has been said, von Sydow's regional colours; but where the browns are carried up into a strong red shade, and the passage from the green to the yellows is not too abrupt, a very good relief effect is obtainable. The choice of the zones to be represented needs some care, for an unsuitable selection throws the features of too large an area into a single shade, as is the case in one wall-map of Africa which has been published.

Colour, therefore, may advantageously supplement contours on topographical maps on the smaller scales, say from 1 : 200,000 upwards, and also on geographical maps, where they usefully indicate the high land masses. The best effect is obtained when several tints or colours are to be seen on a single sheet or map, and if the colours of the scheme have been suitably chosen a good relief effect can be obtained. When certain zones are of especial importance, colour contrast may be usefully employed to emphasize it. In the very small-scale maps of atlases, both contours and colour bands must be most generalized in character, and the regional colours of von Sydow, or some modification of these are the most satisfactory.

Representation of Relief by Shade.—We have seen that the distance between contour-lines gives an idea of the slope of the ground, and that the practised eye can quickly appreciate its form from the now widening, now closely packed lines of equal altitude. More than this, the slope can be accurately determined, since the ratio of the vertical interval to the width of the band between two successive contours at any point is the tangent of the slope. But this in no way constitutes an objective representation of the relief, nor is it the only way of showing it; there are

* Sir C. Watson, Presidential Address, Section E, British Association, Dundee, 1912.

other ways besides the geometrical plan of the relief, which contours furnish accurately. The limitations of contours are well seen in comparing a rugged landscape with an undulating country of low reliefs, for the form of the latter is difficult to appreciate fully without a careful examination of the lines.

For some purposes a knowledge of the slope of the ground is important, and since steep slopes or broken ground may greatly increase the difficulty of military operations, it was early recognized as desirable to indicate all the steeper slopes on maps which were to be used for military purposes. The idea of taking the length of the projected slope-line and thickening it according to the steepness of the surface is due to Major G. J. Lehmann (1765–1811) of the Saxon army, who in 1799 published a book entitled 'Darstellung einer neuen Theorie zur Bezeichnung der schiefen Flächen im Grundriss, oder der Situationszeichnung der Berge,' which may be said to mark the beginning of a scientific system of representing relief by shade. He drew lines in the direction of the steepest slope, that is perpendicular to the direction of contour-lines, and whereas in using contour-lines, the greater the angle of slope, the shorter becomes the plan of the length of surface between two successive horizontal planes, and consequently the closer are the contour-lines, Lehmann made the thickness of each line proportional to the slope and the intervals between them inversely proportional to the same. He took vertical illumination as the starting-point of his theory, and employed the amount of light received by different surfaces as an indication of their slope. But Lehmann's ideas were dominated by military requirements, and therefore, since slopes of more than 45° render ground impracticable for manœuvring upon, he dealt only with slopes of 0°–45°, omitting all larger angles, and laid down that the ratio of the thickness of the hachure lines to the space between each line should be as the angle of slope to the difference between that angle and 45°, *i.e.*

$$L : i = x^\circ : 45^\circ - x$$

where L = width of hachure line,
i = width of the interval between the lines,
and x° = the angle of slope.

Lehmann's Scale of Shade.

But this scheme was too limited to be of universal application, and in mountainous regions, a greater range of slope was needed, so that in some countries a more extended scale of shade has been adopted, as for example in Austria, where the scale of shade is extended to include slopes up to 80°. Such a scale of shade strictly carried out should enable the degree of slope of any part of the surface to be readily seen, but it does not give the relative heights of points or features with the accuracy of contours. On the other hand, the representation of slopes by means of a scale of shade reproduces to a certain extent the form of the country

represented, since the slopes of all parts of the surface are reproduced, but only as seen from a point which can never be occupied in practice—namely, one which is vertically over every point of the region in question. Hilly country, as we ordinarily see it, is viewed by us more or less horizontally, so that we see one side of a ridge, or the trough of a valley, but not the reverse slopes of the ridges which enclose it; for this reason, hachured representation of relief which shows the varying slopes of a region does not reproduce the landscape as it is seen from the points from which we view it. In Europe where the sun is never truly zenithal, deep valleys and steep mountain slopes have usually some portions of their surface in shade, and this alternation of light and shade may be said to be a normal condition in mountain scenery, and has always been recognized as such by artists, as may be seen in even the earliest landscapes. It was then a natural step to obtain a more striking effect of relief by assuming the landscape to be illuminated, not by rays of light perpendicular to the horizontal surfaces, but by light which was inclined to the vertical so that inequalities of ground would throw shadows, although in aiming at increasing the appearance of relief the cartographer departs from the mathematical accuracy of Lehmann's scale in which the shading corresponded with the angle of slope.

But in spite of the advantage of this system in correctly representing slope, hachuring may sometimes be ambiguous, for the lines indicate neither the angle nor the direction of slope, since they are the projection of the slope lines thickened according to the steepness of the ground. Where the differences of relief are considerable there can seldom be any doubt, but on a gently undulating surface it may sometimes be difficult to decide whether the hachure lines indicate a continuous slope or several shorter ones of alternating direction. The more pronounced the relief of a region is the more effective will hachuring be in representing it, since contrast in slope affords the best kind of relief for treatment by this method. Thus hachuring is most suited for use in cases where two diverse elements of topographical form are combined and their slopes are sharply contrasted; it presents effectively the form of the surface but does not express the altitude, though relative elevation is qualitatively shown.

The determination of slope even where hachuring has been carried out on a strict mathematical principle is not a convenient operation, nor is it susceptible of such accuracy as where contours are available.

Hachuring in which the illumination is inclined is in sharp contrast to that in which the illumination is vertical. When vertical rays are replaced by inclined rays, the point from which these start may be such that the illumination may come from any direction and may be inclined at any angle with the ground surface, but the usual practice is to employ illumination which has an inclination of 45°, and which comes from the left-hand top corner, that is, the north-west of the map. It has been

maintained that a more true effect would be obtained if the light was assumed to fall from the south, as reproducing more closely the natural conditions and illuminating those south-facing slopes which receive the greatest share of the sun's rays. There is much truth in this, but at the same time, both in making and reading drawings, etc., a light falling from the left hand is the more convenient and natural, so that so long as the north is placed at the top of the map a north-western lighting seems to be the most practical.

The inclined illumination will vary with the slope of the ground, as in the case of vertical light, but the brilliancy of illumination will vary not solely with the slope, but also with the angle that the surface makes in azimuth with the direction of the light ray, *i.e.* north-west. Consequently—

(1) Equal slopes will not necessarily be equally lighted;
(2) Different slopes may have the same illumination;
(3) Some flat surfaces will be shaded.

In hachured maps, therefore, which employ this kind of illumination, the hachures will indicate the line of slope, but their density and thickness will no longer correspond to the angle of slope, and so while hachures with vertical lighting furnish correctly the form of the ground and its slope, they do not do so when combined with inclined lighting, since equal slopes will then have different shades, and different slopes may have the same shade, since the azimuth angle may be more influential than that of slope. This distorted picture of the relief is most noticeable when hill ranges make the maximum or minimum angle with the direction of illumination. For a range which runs south-west to north-east, and therefore at right angles to the direction of light, will be almost white on one side of the crest and very dark on the other, though both slopes may be of the same inclination, while one which lies north-west to south-east, or parallel to the light, will be equally illuminated on either side, whatever may be the slope. The attempt has been made on some maps to use inclined light for mountains and vertical light for low grounds, but this is an unsatisfactory compromise.

Any good example of inclined illumination will show that this method furnishes a far more striking representation of the general relief of the country than can be obtained by vertical lighting, but the slopes are not so correctly shown, and if the scale will admit, it may be desirable to employ contours in addition in order to correct the impression which the exaggerated shading gives.

Hachuring, when well executed, gives a very natural representation of the ground, but if the slopes are at all steep the map becomes much obscured and the addition of contour lines increases this, as may be seen on the 1 : 75,000 maps of Tirol. This objection is to a large extent removed by printing the hachures in a neutral tint or in a reddish-brown, and of both of these Baedeker's guidebooks furnish excellent examples, inclined

lighting being used to obtain the relief effect. The unavoidable disadvantage of using these lighter colours is that if the detail which is overprinted in black is at all dense, the strong contrast between the black and the rest of the map is so much greater than that between the white and the red-brown that the relief effect is suppressed. Starting with Dufour's map of Switzerland, scale 1 : 100,000, as an excellent example of the successful use of hachure in inclined light we may find the system effectively employed up to scales of about 1 : 500,000, but beyond this the reduction of scale so compresses ridge and valley in mountainous regions that hachuring becomes conventional. These two direction lines then dominate the topography, as Burrard * has pointed out, and spurs, slopes, and minor detail are masked or eliminated. In any case the direction of illumination has to be carefully maintained if effective results are to be reached, as may be seen by comparing the Dufour-Karte with some sheets of the 1 : 253,440 map of the Survey of India, where the hachuring indicates the lighting as coming from almost every direction in turn.

We have now quite left Lehmann's mathematically precise scale of shade for representing the various degrees of slope, and have travelled towards a pictorial representation of the relief.

(*To be continued.*)

AN EXPEDITION TO DUTCH NEW GUINEA.†

By A. F. R. WOLLASTON.

In July, 1911, a paper was read before this Society by Captain (now Major) C. G. Rawling, describing the adventures and misadventures of the British Expedition of 1910–11 to the Mimika river, Dutch New Guinea. One of the objects of that expedition, of which I had the fortune to be a member, was the attainment of the range of Snowy mountains, now called the Nassau range. There is not space here to give any detailed account of the previous exploration of that part of New Guinea; it will, however, be sufficient to say that from the time when those mountains were first seen by Jan Carstensz in 1623 up to 1909 no European had ever approached the foothills of the range. In 1909 Mr. H. A. Lorentz had reached the snow-line of Mount Wilhelmina, distant about 100 miles to the east,‡ but the still higher group of mountains forming the Nassau range was still untouched. Although the Mimika Expedition did much valuable work, geographical, zoological, and ethnological, notably in the discovery of the Tapiro pygmies, it was in many ways attended by the most persistent ill-luck, and chief among its

---

* 'The Geography and Geology of the Himalaya Mountains,' p. 56. Calcutta, 1907.

† Royal Geographical Society, January 26, 1914. Map, p. 364.

‡ The summit of Mount Wilhelmina was reached in February, 1913, by members of the Dutch Government Expedition commanded by Captain Fransse Herderschee.

misfortunes was the selection of that river as a means of approach to the high mountains. We spent fifteen months in the Mimika region, and during that time we reached a point about halfway to the Snow mountains; but I think that even if we had spent twice that time in the country we should not have made much further progress, for reasons that were made sufficiently clear by Captain Rawling in his paper and in the books written by members of the expedition. During those fifteen months we had a view on (I dare say) some one hundred mornings of the distant snows of Mount Idenburg and Mount Carstensz, and any one who has a love of mountains can understand how tantalizing it was, day after day, to see those virgin peaks so comparatively close at hand and yet as unattainable as the mountains of the Moon.

Our experiences in the Mimika Expedition were not such as to give us a strong attachment to that country, but those early morning views of the glistening snow and the keen desire to look over on the other side were responsible for the second expedition, which forms the subject of this paper. Before we left the country I began to make plans for returning to it, and I was fortunately enabled to visit the Utakwa river, where a Dutch Government expedition was exploring with the intention of finding a possible way of crossing New Guinea from south to north. The commanding officer, Captain Van der Bie, had reached the foothills, and he was of the opinion that it might be possible to reach the Snow mountains by that route, so after a consideration of the Neweripa and the Kupera Pukwa rivers, neither of which we now know comes from Mount Carstensz, I decided on the Utakwa river. The Committee of the British Ornithologists' Union, who had been responsible for the Mimika Expedition, very kindly handed over to me the balance of their fund on the understanding that the collections of plants and animals should be given to the Natural History Museum, and with the help of a grant from this Society, and by the generous contributions of friends of my own, whose names I am not permitted to mention, I was enabled to return to New Guinea in May, 1912. We had learnt in the former expedition the grave drawbacks of a large party, so although it was desirable to be accompanied by a geologist and a skilled surveyor, I decided to limit the number of my companions to one only. Here I was fortunate in securing the assistance of Mr. C. Boden Kloss, of the F.M.S. Museum, at Kwala Lumpor, an experienced traveller, who undertook to superintend the zoological and botanical collections. The objects of the expedition were to make collections of animals and plants in the mountains; to study the natives, if any should be found; to ascend, if possible, to the watershed of the Nassau range with a view to determining the extent of the snow and ice, and the connection of Mount Carstensz with the snow-peaks to the west of it; and to obtain a sight of the unknown country lying immediately to the north of the range. It may be stated here that though the Mamberamo river, which reaches the sea on the north coast of the island, and some of its branches have been explored by boat, nothing is known

of the north slopes of the mountains, and the question whether there are ranges still higher than Mount Carstensz is as yet not answered.

At the beginning of July I reached Pontianak on the west coast of Borneo, and thence travelled by steamers and canoes more than 400 miles into the heart of the country to the region of the Batang Lupar Dyaks. It should be said that of all the natives of the Dutch East Indies, the Dyaks alone had been found equal to the strain of cooly work in New Guinea. Mr. Lorentz had taken men from the Mendalem river and had given a very good account of them. So I hoped to get forty men from the Kapuas river, while an agent recruited forty others in Sarawak. I spent seven weeks and had a very interesting time in the Dyak country. They are most hospitable people, in spite of their habit of head-hunting (bunches of skulls, many of them quite recent, may be seen hanging up in every house), but although I smoked much tobacco with them, and consumed many kinds of food and drink in their houses for many weeks, not one would agree to come to New Guinea. Happily, they were in course of time persuaded to change their minds, and when I left them the whole tribe, men, women, and children were anxious to come too. Forty-two men were engaged, and when we had almost arrived at the coast, I was met by the most unwelcome news that the official in charge of the Sarawak Government had forbidden my agent to take Dyaks out of the country, in spite of the instructions of H.H. the Raja, who had given me special permission to do so. It was impossible then to return to the interior of Borneo, so I had to take twenty-four Dyaks, men of an inferior kind, from a rubber plantation near the coast. The expedition was thus seriously handicapped from the start, as with eight Sarawak Dyaks brought by Mr. Kloss from Singapore we had only seventy-four men, of whom many were of little or no use, instead of the eighty that we considered necessary.

On the last day of August we sailed from Java in a steamer that had been most kindly provided for us by the Dutch Government. Our party consisted, beside Mr. Kloss and myself, of an engineer and storekeeper, five native collectors, seventy-four Dyaks, boys, headmen, and others, making a total of ninety-three persons. With us was the Government escort, commanded by Lieutenant Van de Water, whose party consisted of four Dutch sergeants, forty native soldiers, eighty convicts, most of them Buginese from Celebes, and others, bringing the total number of the expedition to 226. It can well be imagined that the equipment for so large a party, and the provisions necessary for seven months, amounted to a very large quantity, so that one ship was not able to carry it all at one time, and the remainder was brought to New Guinea a month later. The great bulk of the stores for my party consisted of 17 tons rice, 1600 lbs. dried meat, 1000 lbs. dried fish, 200 lbs. tea, and 1200 lbs. sugar. The more important articles of the equipment were a 15 h.p. Thornycroft motor-boat 25 feet long, 360 gallons of petrol, 24 tents, tarpaulins, ropes, axes and other tools, red cloth, knives and beads for trading with the

natives, many cases of apparatus for collecting animals and plants, 12 shot guns, and 25,000 cartridges. Every man was supplied with a blanket, a khaki coat and trousers, a woollen sweater, a flannel shirt, and a pair of socks, and a long canvas bag to hold his belongings and, if necessary, to serve as sleeping-bag. Woollen caps and Canadian moccasins were taken for the smaller number of men who were expected to reach the high mountains.*

After spending a few days at Amboina we sailed on September 12, and on the 18th entered the Utakwa river, where the ship was able to anchor about 15 miles from the mouth. On the same day we made an excursion to the spot, about 20 miles further up the Setekwa branch of the river, where Captain Van der Bie had made his base camp in 1910. The place was not easily found, as it was densely overgrown with jungle and trees, some of them as much as 30 feet high, so rapidly does vegetation grow in that climate. That was a day of many mishaps; the Dutch steam launch lost its propeller on one of the many snags which bristle in the river, and while we were towing it the pump of the motor became choked with sand and smashed, which delayed us for several hours. As if that were not enough, while we were creeping cautiously down the river towards midnight, a large tree leaned over from the bank and crashed right across our course—a few seconds later it would have smashed our little boat to pieces, and the expedition would have come to an untimely end. The following ten days were occupied in bringing up all the stores and gear from the ship and in clearing the ground for the base camp. In the course of time some 5 acres of land were cleared, and the Dutch contingent, many of whom remained down there all the time, had fine gardens of maize and cucumbers. As soon as possible the Dyaks set to work to make canoes, without which no further progress could be made. In the Mimika Expedition we had depended on the canoes of the natives, but in the Utakwa river there was no population, and it was some time before we were visited by natives from other places from whom canoes could be bought. Moreover, the Dyak canoes are more roomy and lighter and more easily handled in rapid water than those of the Papuans. In ten days four large canoes were made, and we proceeded two days' journey up the river to a place beyond which it was not practicable to go by water. There a secondary base camp, the Canoe camp, was formed, and the following weeks were occupied in stocking it with provisions. Before long, natives from other rivers came up the Utakwa to visit us, and we were particularly gratified at receiving a visit from the headman of Nimé and many of the people of Wakatimi, whom we had known well on the Mimika river two years earlier. They had come about 80 miles by water to see us, passing

* The P. & O. Steam Navigation Company most generously transported the motor-boat, the whole of my equipment and stores for Europeans, from London to Singapore free of charge.

on their way tribes with whom they were always at war; they had spent two nights on the way. I have said above that there was no population on the Utakwa river, but though there were no permanent dwellings, there were on the upper reaches of the river small shelters occupied occasionally by natives from other rivers, who came there to obtain the bread-fruit, on which they seem principally to subsist. These people used to appear and disappear in the most unaccountable way, and they caused us considerable inconvenience by waylaying and trying to steal things from the canoes. On one occasion they laid a tree across the river, and a large number of them rushed down to attack the canoes in such determined fashion that firearms had to be used to drive them away. On another occasion a large party of Papuans from the coast followed our canoes up the river and began to quarrel with the Dyaks, at whom they proceeded to throw stones. The Dyaks, I am sorry to say, all ran away and left two boat-loads of stores, including warm clothing and special stores for the high mountains. Those natives of the coast and of the low country were always on the look-out for a chance of stealing, but thanks to our escort we were always well guarded, and on the whole we had very little trouble with them.

When a sufficient quantity of stores had been accumulated at the Canoe camp, we started on our overland journey in a north-westerly direction, following the route of Captain Van der Bie, which was in many places still clearly visible. It was our object to establish depôts of food at distances of three days' journey from one another. The arithmetic of depôt-making is a somewhat complicated affair, but it will be sufficient here to say that if, for instance, you wish to arrive at a place twelve days' journey distant, in the given circumstances it is more economical and quicker to make three intermediate stores of food at distances of three days apart than two stores at intervals of four marches. Our first food depôt was in the first range of foothills at a height of about 2300 feet, and it was of great importance to us, partly because it was the first place where we found ourselves comparatively cool at night, and above the leeches and other objectionable creatures of the low swampy country, but chiefly because from a point near by, called the Observation point, we obtained the only comprehensive view that we ever saw of the range of mountains, and we were able to some extent to plan our probable route to the higher regions. To the extreme west were clearly visible the mountains at the head of the Mimika, Mount Tapiro, Mount Tuaba, Wataikwa, and Godman. Standing far behind the latter was the imposing precipice of Mount Leonard Darwin. In the north-west were the Cockscomb and Venusberg, and due north the gleaming snow on the two peaks of Mount Carstensz. To the right of that Mount Utakwa with many steep forest-covered ridges, the rugged wall of the Cartel mountains like Dolomites, the gentler slopes of Mount Lemaire, and in the east many more spurs spreading out on to the low lying land.

The formation of the foothills is exceedingly complex. The ground on

MOUNT CARSTENSZ FROM THE SOUTH (TELEPHOTO 30 MILES).

MOUNT LEONARD DARWIN FROM SOUTH-EAST (TELEPHOTO 40 MILES).

NATIVE HUT IN MOUNTAINS (6000 FEET).

VALLEY OF UTAKWA (BAUDERONG) (6000 FEET).

which the first depôt camp was situated was a light-coloured limestone rock; a few miles to the south-east was a steep ridge, along the top of which was an outcrop of pure coral rock; and a few miles to the north-west of it the ridges between the various river valleys appeared to be made entirely of boulders and gravel. From the Observation camp one day's march brought us into the main valley of the Utakwa river, and two days further on a second depôt camp was made at an altitude (1988 feet) less than that of the Observation camp, in spite of the fact that between the two we had climbed and descended many thousands of feet. At that point the precipitous character of the left bank made it necessary to cross the river, which was there about 45 yards wide. The natives were accustomed to use a long rope of rattan stretched high above the water from bank to bank. Hanging to the rope were hoops of twisted rattan through which they thrust their legs; then after sliding down to the middle of the rope they hauled themselves up to the further side, a difficult and perilous performance. On a day of exceptionally low water a bridge was made across the river from boulder to boulder; this was washed away during the following night, and was subsequently replaced by a suspension bridge of rattans from bank to bank.

In December we made a preliminary excursion of six days in order to find out, if possible, the best way of reaching the high mountains. After leaving the second depôt camp, we soon reached an altitude of 5000 feet, and except for an occasional descent to cross some tributary stream, we did not again find ourselves below that level. On the top of the first steep ridge we came to the first native dwelling that we had seen in the country, and as it was typical of the rest it will be convenient to describe it here. It was a rectangular wooden structure, raised on piles about 5 feet from the ground. A sloping ladder of two or three poles tied together leads to a narrow platform, behind which is the living-room, about 10 or 12 feet square. In the middle of the floor is a square fireplace, usually lined with sand or small stones. The walls are made of split poles placed closely together, and the roof is made of the leaves of pandanus, or of a palm if any happens to grow in the neighbourhood. There was a mystery about that first house, which we were never able to solve. It was evidently quite newly built, a small clearing had been made about it, and a few banana and dracœnas recently planted. Outside the house were a number of men, women, and children, the men occupied in cooking large quantities of yams and sweet potatoes and great lumps of pig's flesh. We naturally supposed that it was a sort of house-warming, as in one sense it turned out to be. The men shook their heads and pointed in a mysterious way towards the house and made the curious sign which they are accustomed to make when they talk of something disagreeable. Then they invited us to enter the house, where we found an old man sitting by the fire. He was diseased and decrepit, but appeared by no means likely to die. He took a keen interest in our appearance, and enjoyed the tobacco which we

gave him. When we returned five days later, we found the place utterly deserted and the house a blackened heap of ashes, on the top of which were lying the charred remains of human bones. It was impossible for any one to say five days earlier that the old man was going to die—indeed, he might have lived for months, or even years. What we may imagine to have happened was this: that as he was unable to get about any longer and find his own food, his relations did not intend to support him, and that the preparations we saw were really for his funeral feast; but we were puzzled by their having cremated him in a newly-built house.

A few miles further on we were joined by some twenty or thirty natives, who accompanied us and were eager to relieve the Dyaks of their loads. On the following day our track lay along a knife-edged ridge between the Utakwa and its tributary, the Nusula-narong, more than a thousand feet below us, and there it appeared that we passed from the region of one tribe into that of another. After passing through a wooden fence set across the ridge, we came upon an open level space of bare ground about the size of a lawn-tennis court, where we found a crowd of sixty or seventy people of both sexes and all ages, who set up the most astonishing barking noise when we appeared. Many of them danced or pranced up and down the platform, and many crowded round and shook hands, or rather pulled knuckles, with us. After a time we were told to stand with our party at one end of the platform while the people who belonged to the country beyond stood at the other, an open space being left between. Then a man, who appeared to have some authority, ordered silence, and began a long harangue; in one hand he held an axe, and in the other two white leaves, with both of which he gesticulated freely in our direction. Towards the end of his speech a lean white pig was brought in from the back of the crowd, and I was instructed to go forward and receive it. Fortunately, he presented me also with a small boy and girl as guardians of the animal, and we agreed to fetch it on our return, but, of course, we never saw it again. We gave them small presents, and were then allowed to continue our way along the ridge, which we followed for two days' further march. We were accompanied by a crowd of natives, who showed us a track, and sometimes led us by an unnecessarily devious route in order to exhibit us to their friends. Whenever they came within shouting distance of a house, they all stopped and shouted together until their cry was answered. Some utter a deep "Wah," some a high-pitched jödelling sort of note, and others according to the compass of their voices, but each one a single note only; the effect is very pleasing, and at a distance it reminds you uncommonly of the cry of a pack of hounds.

The farthest point we reached on that excursion was a level depression, having the appearance of an old lake basin about half a mile wide, scooped out of the west side of the Utakwa valley. The sides and floor of the basin had been cleared of jungle and planted with sweet potatoes. Within a radius of half a mile there were about twenty houses, scattered about in

groups of three or four. The whole population visited us at our camp, and until darkness fell we were the centre of a somewhat embarrassing crowd. While the women and infants hung about the outskirts of the throng, the men and boys pressed about us as many as could come near us at one time; they peered inside our scanty garments, pulled us about, pulled our hair and beards, stroked us and fondled us in a manner to which I am quite unaccustomed. They are not acquainted with the use of water, so it may be believed that these attentions were far from pleasant. During their visit we heard loud shouts, and soon another crowd of men and boys came racing down the mountain-side from the north; they ran towards us in single file, and then forming themselves into a wheel-shaped figure on a small level space, they ran round and round, barking and shouting and waving their bows and arrows.

After returning from that preliminary excursion, which served to show us that there was a good prospect of reaching the high mountains by that route, we waited for several weeks while food was being accumulated for our further advance, and it was not until January 17 that we again set out from the camp at Observation point. In seven days we established a small depôt of food at a place 2 miles further up the valley than the point reached on our preliminary excursion. At that place, 6000 feet, there were three native huts and a small area of cleared ground, the last we met with, as beyond that point the valley became so narrow and the slopes so steep that cultivation, even for a Papuan, was impossible. Near that place on the left bank of the river, which we crossed by means of a bridge of poles from boulder to boulder, is a spring of hot water (temperature 94° F.), milky white, and with a strong sulphurous smell. The water oozes out of the ground in several places, and in one place the natives have dammed it up to make a round pool about 15 feet across and 2 or 3 feet deep. The people who accompanied us plucked long grass stems, through which they sucked up the water as one does through straws. Afterwards one of them waded into the pool and lifted from the bottom an armful of fern-fronds, which had previously been left to soak in the water. These they carried away with them to chew at their leisure. They gave us by unmistakable signs to understand that the water and the salt they get from it is good medicine.

On January 26, we left that camp, accompanied by a few natives, who had been up the valley before. Though we saw in one or two places traces of fire under stones, where they had evidently rested, there was no track, and our progress was exceedingly slow and arduous. It was impossible to follow the river, which was a roaring torrent, confined in many places between sheer walls of rock; it was equally impossible to cut a track along the slopes above, for they were much too steep and were constantly broken by precipitous watercourses, divided from each other by sharp ridges. So our course was a series of toilsome ascents to avoid precipices and heart-breaking descents again to the bank of the river, so that

our first day's march, though it involved climbing several thousands of feet, resulted in bringing us up only about 600 feet. It was wonderful that we met with no disaster, for the great weight of men clambering along those slopes was quite likely to cause one of the landslides which occur so frequently. In the steeper places the vegetation is only small trees growing on a thin carpet of mosses and orchids, and a little extra weight on it will cause the whole to slide off the slippery rock to which it clings into the depths below. With the help of ropes and rattans, we traversed those places as lightly as possible. Sometimes we scrambled over the boulders of the river-bed, and in one place a sheer rock seemed to block our way completely; a young tree was felled and thrown along the side of the rock to the head of the pool, where it jammed between two stones under water, then we sidled carefully along it, feeling for it with our feet about a yard under water, as it was a mere sapling and bent like a fishing-rod; there was nothing to hold on to as the rock was sheer and slippery, and the water was running like a mill-race. Had a man slipped there he would never have been seen again. At about 7000 feet there began to be a noticeable diminution in the size of the trees of the jungle, and the undergrowth, which was up to that altitude extremely thick and difficult to penetrate, became less dense. On the third day at 8000 feet the valley became wider and the character of the vegetation changed completely; the large forest trees of the lower ranges disappeared, and their place was taken by pandanus and tall fir-like casuarinas. Above that altitude trees thinned out very rapidly, and the last trees (*Podocarpus papuanus*) were seen at about 10,500 feet.

The region between 8000 feet and 10,000 feet was by far the pleasantest we had yet traversed in the country. Our way lay up the rocky bed of a stream, one of the sources of the Utakwa, and the banks were covered with flowering shrubs, and many flowers of a familiar appearance, a small geranium, a sort of meadowsweet, a little blue gentian, and numerous terrestrial orchids, some of them very beautiful. In front of us were the towering precipices and the gleaming ice of Mount Carstensz, and behind us lay the deep valley of the Utakwa and the many steep forest-covered ridges we had so painfully traversed. But it was never for long that we had any view at all. Every day in those higher regions the clouds descend about 9 a.m., followed soon by rain, so that during the latter part of those days' march we were groping blindly through the fog, and all were drenched to the skin. For many days we were never dry night or day, and by reason of the consequent softness of our skins, we were painfully scratched and cut by bushes and rocks. Every scratch became infected and quickly suppurated, and Kloss' hands were in such a deplorable condition that for several days he was unable to hold a pencil. The feet of the coolies, whether they wore boots or not, were dreadfully cut about, and their labour was very severe. At our camp at 10,500 feet it became evident that we should not be able to proceed further with a large party of men,

VIEW DOWN UTAKWA VALLEY FROM 13,000 FEET ON MOUNT CARSTENSZ.
(Photo: C. B. Kloss.)

VALLEY OF THE UTAKWA AT 4000 FEET.
(Photo: C. B. Kloss.)

ICEFALL OF CARSTENSZ GLACIER.
(*Photo: C. B. Kloss.*)

ICE ABOVE THE CLIFFS OF MOUNT CARSTENSZ.
(*Photo: C. B. Kloss.*)

as we were at the foot of the great cliffs of Mount Carstensz, on which it would be very difficult to find even a small camping-ground, and the men were beginning to suffer from the cold. A serious drawback was the difficulty of cooking; the meagre brushwood was wet and unwilling to burn; the temperature of boiling water was so low that rice had to be cooked for a very long time; the result was that many men ate their food only half cooked, and many stomachs were disordered.

On January 30, Mr. Van de Water and I, with a few followers, including three Papuans, pushed on in the hope of finding a practicable way to the snow. For a mile or so we cut our way through a very dense moss-forest, interrupted here and there by patches of bog, then a steep ascent brought us on to a little col between the main mountain and an outlying spur which had hitherto cut off our view. At last we stood on hard, stony ground, unencumbered by the hateful vegetation, and were free to turn and gaze upon the land below us. At our feet lay the Utakwa and its many branches arising from Mount Utakwa and Mount Venus; clearly distinguishable was the clearing in the trees near our camp at Observation point. To the south-west were the many tops of Mount Cockscomb, and to the west the view was limited by the splendid mass of an unnamed mountain, a buttress of Mount Carstensz, resplendent with bands of red and yellow rock. Beyond the lowest hills lay the wide brown plain of heavy forest, water-logged jungle reaching to the distant grey line of sea. Here and there could be seen gleaming in the sunlight wide reaches of the great rivers winding through the forest, the Wania, Kamura, Neweripa, and very many others. Behind us towered the great cliffs of Carstensz, so steep that we could not see even the lower limits of the snow. Fortunately, the south face of the mountain is not a sheer wall of rock; it is interrupted here and there by projecting buttresses at a gentler angle and by occasional terraces or platforms covered with broken fragments fallen from the cliffs above. At about 13,500 feet, vegetation, except a daisy and a few grasses, came to an end. There we encountered a steep wall of limestone rock, which at first sight appeared to bar our further progress; one of the Papuans—they can climb like cats—found a way up it, and by means of an alpine rope we were able to return that way in safety. Then a stiff scramble up smooth rocks brought us, at 14,200 feet, to the lower limit of permanent snow. This was a steepish slope of snow, leading up to a wall of ice, whose seracs, 50 and more feet high, seemed to be toppling almost over our heads; scattered about the snow were fragments of ice lately fallen. It was then too late to search for a further passage, so we descended to our camp 4000 feet below.

On the following day Mr. Kloss and I, with half a dozen Dyaks, made a camp above 12,000 feet. We were prevented from going higher by heavy rain which fell during our ascent. It was curious to observe that as soon as the rain ceased, the water which had been coursing down the mountain-side immediately disappeared, soaking into the very porous sandstone

(Photo: C. E. Kloss.)

which occurs at that level; so no more water was obtainable until rain fell on the following day. There we spent a night which, judged even by the low standard of New Guinea comfort, was one of the most disagreeable I can remember. On the morning of February 1 clouds were low on the mountains, and no distant view was seen; by the time we reached the snow we were in thick mist, and it was obvious that we should not see much, even if we attained to the summit ridge. We skirted along the face of the mountain westward, following a more or less horizontal terrace for about half a mile until we came to another easy slope of snow. This we followed until (at 14,866 feet) we found our further progress barred on the one hand by precipitous rocks, and on the other by a steep wall of ice, the abrupt termination of the ice-field above. Either of these obstacles might have been overcome by a party of three competent alpine climbers, but for two people to make the attempt in fog and rain would only have been to court disaster. Had we had time to skirt the mountain further to the west, we should certainly have found a less difficult way of ascent, but in the circumstances that was impossible. The point which we reached was near the dip between the eastern and western peaks of the mountain, and was, I am sure, considerably less than five hundred feet below the summit ridge. From the eastern summit of Mount Carstensz (15,708 feet) an ice-field, much crevassed as we saw from a distance, slopes down at a fairly steep angle to about 15,000 feet, where the angle of the underlying rock becomes so steep that ice and snow can no longer lie on it; the result is that in most places the limit of the ice-field is an abrupt wall of broken ice, like that which confronted us. In one or two places where the rocks are not quite precipitous, the ice trickles down, though even there very steeply, to a lower level. Judging from the formation of the mountain, it is fairly safe to assume that on the other side the slope would be considerably less steep and the limit of snow and ice would be correspondingly lower. That was, of course, one of the questions which we had hoped that an ascent of the mountain would enable us to answer.

I need not here dwell upon our feelings of disappointment as we slowly stumbled down to our camp again. I had known well the southern face of Carstensz for three years, and I had often dreamed of reaching the ridge and seeing the unknown country beyond unfold itself range by range, higher mountains still, perhaps, who knows? To have the prize withheld when it was nearly within our grasp, was almost more than Christian patience could bear. However, it still awaits another opportunity. During the following days, as we went down the valley, our disappointment was a little mitigated by seeing Carstensz always in the clouds; had we been there still, we could have seen no view. The rest of the month of February was spent at different places in the mountains in making collections of animals and plants, and in March we returned by degrees to our base camp on the Utakwa river in readiness to leave the country at the beginning of April.

It may be believed that the transportation of a large number of men and a great quantity of stores up and down a rapid river like the Utakwa was attended with a good deal of difficulty. The rocks and snags and rapids were a constant source of trouble even at low water, and when the frequent floods came down from the mountains, as they did with startling suddenness, of some danger also; thus in one night our fleet of thirteen canoes was swept away from the Canoe camp, and only five, all more or less damaged, were recovered; fragments of the others were found scattered for miles down the river. But the Dyaks were good watermen, and we were very lucky in avoiding accidents, and it was only once that a serious mishap occurred. I had waited at the Canoe camp until all the collections and the important gear had been sent down to the base camp, a business which occupied several days. Then I started down the river with six Dyaks in a canoe laden with the last valuable possessions. The river was fairly full, favourable for making a quick passage, but unfortunately a few miles down the flood of the preceding night had left a new snag jammed in the middle of one of the deepest and narrowest rapids. We were unable to avoid touching this, and immediately we found ourselves all struggling in the torrent. One of the Dyaks and I scrambled on to the overturned canoe and went sailing down stream at 7 or 8 miles an hour. In a short space we came to a large tree which had fallen from the bank and lay partially submerged across the river; the Dyak shouted to me to get off the canoe, but I was encumbered with boots and clothes, and not being at best a strong swimmer, I was slow to do so, and got caught by the current, which dragged me down into the branches of the tree under water, where I was held by the heavy force of the stream. It seemed impossible to get free in spite of my furious struggles, and things looked very black, until later I found myself in the sun again and floating down the river. The current drifted me on to a stony shallow, where I was rolled along towards another deep rapid, which would certainly have ended my troubles; happily, the Dyaks came to my rescue, and dragged me ashore. Much worse than my bodily distress was the fact that everything was lost that had been in the canoe, including all my notes and diaries of the last three months, the map I had made of the country, many instruments belonging to this Society, valuable plants and seeds from the high mountains, two cameras, a medicine chest, and all my portable personal property. The loss of the map and diaries was the most serious blow; the map illustrating this paper is made from sheets which had been discarded, from sketches, and from my book of prismatic compass bearings which was in my pocket and not lost.

The Native Populations.

There are three distinct native populations.

(*a*) The people on the coast. Near the mouth of the Utakwa river itself there is no resident population, probably on account of the absence

of sago from that region. We were often visited by parties of Papuans from other rivers to the westward, and before we left the country we made an excursion to the Inabuka and Kupera Pukwa rivers; on the coast we found a large number of natives and about 20 miles up the latter river we came to a village of sixty or seventy huts of the same type as those found in the Mimika district. These people speak a dialect very similar to that of the Mimika people, and as a full description of them was given in Captain Rawling's paper, I will say no more about them here.

(*b*) On the upper navigable waters of the Utakwa we occasionally came across small parties of Papuans in canoes smaller than those used by the coast natives. These people certainly did not come up from the coast; they came, I believe, from the country to the west in search of the fruits of the breadfruit tree, which were numerous in some places. They had no permanent habitations on the Utakwa, but in many places we found their temporary huts, which they used on their occasional visits to the river. They were very poor people, possessing hardly anything, and their height and physique appeared to be inferior to that of the coast people, but we had no opportunity of measuring them. They understood very little of the Mimika dialect, which was familiar to the natives of the coast. These were the people who caused us occasional trouble, as related above.

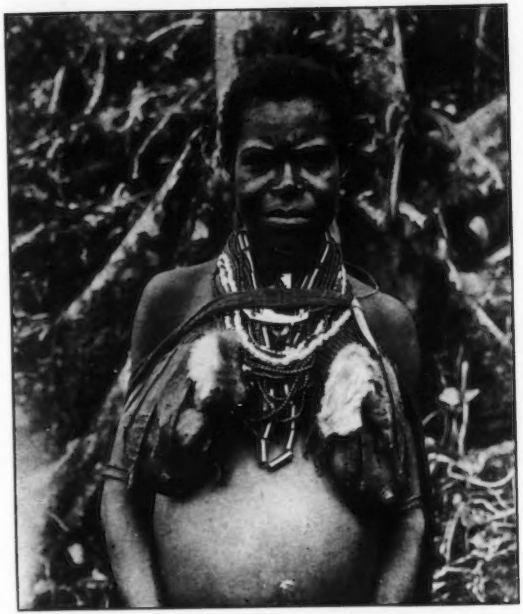
(*c*) The mountain people, who are found living between 4000 and 6000 feet. These people make well-constructed huts, described above, and they cut down the forest on the less precipitous slopes of the mountains and grow sweet potatoes, on which they principally live; they also grow a few plantains, a small quantity of sugar-cane, collocasia, ginger, and tobacco. In places where the slopes are very steep they terrace the ground with logs of trees to prevent a landslide. The highest cultivated land we came to was at 6000 feet, but on the less steep slopes of Mount Venus we saw in the distance cleared ground between 7000 and 8000 feet. It is not easy to estimate the population; we saw, perhaps, between 300 and 400 people, many of whom doubtless came long distances to visit us. From the beginning they were always very friendly; they came of their own accord down to our first depôt camp two days after it was established, bringing with them their wives and children, and for the following three months there were always some of them camped at that place. They were quite fearless from the first; they strolled into our tents or huts as if they had been accustomed to do so all their lives. There appeared to be a larger number of men than women; I am not aware that either polyandry or polygamy is practised. There are no separate houses for men or for women, both sexes inhabiting the same house; no one man appears to be a chief, though the old men give orders, which are sometimes obeyed by the younger. Many of the men appear to have two names.

In size they are smallish people—the average height of twenty men was 153·3 cms. (5 feet $\frac{1}{3}$ inch); they are noticeably taller than the Tapiro pygmies, whose average height is 144·6 cms., and we saw several men of at

MOUNTAIN MEN (SMEARED WITH MUD IN MOURNING).

MOUNTAIN WOMEN.
(*Photo: C. B. Kloss.*)

MOUNTAIN MAN (WEARING CASSOWARY FEATHER HEADDRESS).



MOUNTAIN WOMAN.

least 5 feet 8 inches (172·7 cms.). They are strong and well built, calves and buttocks finely developed, and they run and walk up or downhill very actively. At first sight they appear to be almost black, but most of this is due to the filthy condition of their skins, caked with dirt and sweat. Some of those who visited us shaved their heads and soaped themselves, with the result that their skins showed a brownish-yellow. The hair on the head is short and woolly, not dressed at all; whiskers and short beards are frequent. Many of them have a very uniform growth of hair all over the body and limbs. The septum of the nose is pierced and a pig tusk sometimes worn. The *alæ nasi* are not pierced. The lobe of the ear is pierced for ornaments, which are commonly worn. Neither tattooing nor scarification is practised. The men like to paint the upper half of the face red with clay, or black with a mixture of grease and charcoal.

The dress of the men consists only of a long tapering gourd case, similar to that worn by the Tapiro pygmies; it is kept in position by a string round the waist and hanging over it at the base, in the manner of a sporran, is a double tassel of knotted strings. The women wear a short skirt, about a foot in depth, made of bark or leaves, which always seems to be just on the point of slipping off behind. All of them, men, women, and children, carry one or more bags of netted (purse-stitch) string; a big one slung like a haversack across the shoulder, and a small one, a sort of treasure bag, hanging round the neck. In the big bag nearly all their worldly goods are carried, their pandanus mat, tobacco, firesticks, food and all sorts of odds and ends. I have seen a woman carrying in her bag, in addition to the usual gear, a baby, a young pig, and at least a hundred sweet potatoes. Necklaces of seeds, beads, yellow dendrobium stems, teeth of pigs, bones of rats, bits of broken shell, etc., are worn by both men and women. Another common ornament is a sort of fillet made of the upper arm-bones of a small mammal worn in the hair. The most imposing of all their decorations is the "busby" headdress of cassowary feathers fastened on to a hoop of wood; it gives the man a very fierce and warlike appearance. Most of the men wear a loosely fitting belt made of long strips of rattan tied end to end and wound loosely about the body. Some of them have a few glass beads, and many have sea-shells, cowries, etc.; when asked where these came from, they always pointed not to the sea, but to the east. We also saw three or four iron axes of unknown origin. Their usual weapons are bows and arrows, which the men and boys carry at all times; the arrows are of several kinds, each one with a distinguishing name, and they resemble those of the Tapiro people, and are much better made and finished than those of the coast Papuans. A few of the men carry a small shield, about 20 inches long by 8 inches wide, made of a thin sheet of light wood. This is fastened in an elaborate manner to the large bag worn on the left side of the body, in such a way that when it is required for purposes of defence it can be immediately swung forward to protect the left shoulder and breast. Many of them have stone axes; the head is

MOUNTAIN MAN (WEARING CASSO

made of a metamorphosed slate, which is capable of taking on a very sharp edge, and is set in a wooden shaft. Nearly every man carries a stone knife, a straight or slightly sickle-shaped flake of calc-flinta about 1 inch wide and 4 to 8 inches in length; some of these are sharp enough to cut small bamboos. They also use roughly chipped flakes of a flinty stone to carve or sharpen arrows; the lower jaws of rats are also used for the same purpose. Many of them use a spoon made from the shoulder-blade of a pig or other mammal, with which they scoop out the soft inside of cooked potatoes. They possess a few pigs, which they eat on occasions; the tails and larger teeth are preserved and tied in bunches to the corners of the bags they carry.

Fire is made by the friction of wood and rattan in the manner practised by the Tapiro; but whereas the Tapiro carry their rattan as a long piece neatly coiled into a ring, these people carry it in short lengths, each piece sufficient for one operation. Cooking is more elaborate than with the people of the coast; a basin-like hole about 3 feet wide and 2 feet deep is made in the ground, then stones heated in a fire are wrapped in leaves and laid as a lining over the inside of the hole, and then the meat or roots to be cooked, also wrapped in leaves, are laid upon the hot stones, and then more hot stones upon them.

Tobacco is cultivated, and the leaves are rolled into a thin rope, which is coiled up into a neat ball, and then dried and wrapped in leaves. It is usually consumed in cigarettes, the wrapper being made of banana or pandanus leaf. Occasionally they smoke pipes, a short straight piece of bamboo, or a hollow nut with the bone of a bird's wing for a stem. Men, women, and children all smoke. So far as we know, they make no intoxicating drink. We saw nothing that led us to suppose that they practise cannibalism. The usual method of burial is to tie the body in a sitting position, and to lower it into a round hole in the ground about 4 feet deep. When anybody is very sick, or is dead, or if they are talking about something unpleasant, as, for instance, about the snow at the top of "Ingkipulu" (the name by which they know Mount Carstensz), they have a curious habit of lifting up the right nostril with the right thumb and making an expression of disgust. After a death has occurred, it is the custom for the men to smear their bodies with mud. When two people meet, they do not shake hands, but pull knuckles, thus: one man puts the knuckle of his first finger between the knuckles of the first and second fingers of the other, then they pull them apart with a sharp click, uttering the sound, "Wah"; this is repeated three or four times. Another form of greeting is to raise the brows two or three times, nodding the head to the side once and smiling at the same time. Many of them have very agreeable smiles. They expect you to wrinkle your brows and nod and smile to them, and we found the exercise very tiring when a large crowd of people visited us. Men express surprise or astonishment or interest in any new thing by clicking the hollow gourd case with the thumbnail.

Their voices are loud and harsh, and they talk incessantly; they also

laugh a great deal, and in temperament they remind one much more of African people than do the more silent and morose Papuans of the coast. We made a considerable vocabulary, but mainly of the names of concrete things. Unlike the people of the coast, who have words for one and two but no word for three or any higher number, these people have words for all the numbers up to ten, though there was often some vagueness about the last three. In reckoning higher numbers, they make use of the fingers and toes. The difficulty of learning their language cut us off from a great deal of information, which they were always willing to impart to us, but they showed a very ready intelligence in communicating with us by means of signs. There was a man among them who claimed to have been to Mount Carstensz; he described most graphically the steepness of the ascent, and by shuddering and chattering his teeth he told us how cold it was up there. When we showed him white paper and pointed to the mountains, he nodded assent, but we were still not quite convinced that he had been actually to the snow, until he acted for us in this way: he made a motion as of scooping something from the ground with both palms, then he called another man to bring a gourd vessel, over which he pretended to squeeze vigorously what was in his hands, after which he did the action of drinking out of the gourd.

We saw no houses used for ceremonies, no carved images, nor any sign of any form of worship; nor did we see them play any kind of game, but they are familiar with the cat's cradle, of which they make many elaborate figures. They sometimes sing, not unmusically, but they have no other musical instrument beside the jews' harp. Most of them are splendidly healthy in appearance, but I saw two or three people who seemed to be undoubtedly syphilitic. There were a considerable number of men and boys blind in one eye; whether this was the result of accident or whether it had been intentionally done, I was unable to learn.

It has been said above that these people lived in the mountains between the altitudes of 4000 and 6000 feet, but that they do occasionally come lower down, probably in search of pigs or cassowaries, was evident from the shelters of palm leaves, which we found at about 2000 feet in the first foothills. Many of them came down to visit us at our camp at Observation point and at the Canoe camp, and some even went as far as our base camp far down the river. They arrived at these places with their wives and children and a few pigs and sweet potatoes enough to last them for several days. When their food came to an end they begged food from the soldiers and coolies in the camps, but our provisions were not calculated for an unlimited number of visitors, and soon it became necessary for the people in charge of these camps to refuse to give them any more food and to tell them to return to their homes in the hills. In the middle of February, when we were returning from Mount Carstensz, a few miles before we reached the second depôt camp, we were horrified to find two recently dead bodies on the track. At the depôt camp we heard that there

were many more dead people down below, and during the next two days' march down to the camp at Observation point, two days of the most terrible that I have ever experienced, we passed the dead bodies of between thirty and forty people. All of them were on, or very close to, the track; some had made shelters of sticks and leaves, and others had crept, four or five together, into the shelter of rocks, and had died beside the ashes of their fires. One of their shelters was built right in the track, so that we had to cut another path through the jungle to avoid it. Mr. Kloss, walking alone, did not notice the newly-cut track, but stumbled suddenly into the shelter, and there, among three bodies of a woman and two children most horribly dead, he noticed one that still seemed to be brown and living. It was a small girl of about three years old, who had evidently been left in that place when the others were either dead or dying; he carried it several miles to the camp, where we fed it with milk, but the poor little creature died a few hours later. There were so many dead that at first I thought they must have been the victims of a sudden epidemic, but none of them showed any sign of disease, and what I imagine to have happened was this: these people set out on their return journey to the mountains not in the best of condition after varying periods of inadequate food; they were encumbered with women and small children, whose rate of progress up and down the innumerable steep ridges to be traversed was painfully slow. There was no food of any sort, excepting the hearts of occasional palm trees, to be found in the jungle, and faced by several days' hard travelling ahead of them and growing weaker daily, they just gave up and died, as natives can. They did not appear to be extremely emaciated, but still their deaths can only be accounted for by weakness and starvation. The stronger won home to the mountains, leaving the weaker, mostly women and children, to die by the way. A man and a woman died at one of the camps, leaving two children, one of whom also died, and nothing would induce any of the others to take away the remaining child, whom we eventually brought with us to Amboina. I have related this at some length, because I think it will show more clearly than anything else what an utterly hopeless and heart-breaking country that is, where not even the natives, who are accustomed to a hand-to-mouth existence, can keep themselves alive.

Physical Features of the Country.

The trend of the coast-line being south-east, and the direction of the mountains almost due east and west, it follows that as you proceed towards the east the belt of low-lying land becomes wider; thus, at the Mimika there are about 40 miles between the coast and the mountains, at the Utakwa 60, and at the Island River about 120 miles. The whole of this intervening land lies at a very low level, several miles adjacent to the sea being flooded at high tide, and the further parts being constantly submerged for days at a time by the overflowing of the many rivers by which it is traversed. The soil is alluvial mud and sand, devoid of any stones or pebbles; it is

covered everywhere by a very dense jungle. It has been assumed, on grounds that need not be detailed here, that this low-lying belt of country is in a condition of subsidence. The first appearance of any outcrop of rock is seen at about 30 miles from the sea, where are found in the river-banks horizontal beds of a curious vegetable deposit, harder than peat but softer than coal.

The foothills rise somewhat abruptly from the low ground to a height of 2000 feet and upwards; they appear to be composed largely of red and yellow sandstone, and in two or three places we came across outcrops of solid coral rock. Small boulders of granite and other eruptive rocks were found in the bed of the Utakwa river near the foothills, but none were discovered *in situ*. When you stand on the top of the foothills and look northwards, there appear to be three principal ranges: the foothills themselves, with a general direction east and west; north of them a very much broken country deeply cut by the valleys of the Utakwa and other rivers with their affluents; at a distance of about 10 miles from the foothills is a second or intermediate range of mountains, the Cockscomb, Mounts Venus, Utakwa, and Lemaire, varying in height between 8000 and 12,000 feet; at a further distance of about 10 miles, and connected with the intermediate range by long sharp ridges, is the main range of mountains culminating in the snow-topped peaks of Mounts Idenburg and Carstensz. At the foot of the second range shales and slates were found in many places, and sandstone was found at a high altitude on Mount Carstensz, but the rock of which both the second and third ranges are mainly composed appears to be limestone. Thin seams of a very inferior kind of coal were found at altitudes of 6000 and 9000 feet. Mount Carstensz itself, and the range of which it forms a part, is a great limestone escarpment, with a general direction west by north and east by south; the strata dip towards the north at an angle of from 20 to (in some places) as much as 60 degrees. In some places, particularly Mounts Leonard Darwin and Idenburg to the west, and the Cartel mountains to the east, the south face of the escarpment is so steep as to be practically a precipice. Recent explorations to the east make it almost certain that the Nassau range is a continuation of the great central range, which runs from west to east through the island. There does not appear to be any considerable interruption of it in any place. At the present time the lowest limit of permanent snow is at 14,200 feet, but there are many signs of former glaciation on the rocks down to about 12,000 feet, and in the bed of the stream at 8500 feet I saw large boulders, which show unmistakable evidence of having been worn and scratched by ice.

Botany.

A very large collection of dried plants was made by Mr. Kloss, but they have not yet been all described, and a full report will be made of them elsewhere. It may, however, be of interest to record here a few points about the vegetation of the country. It is commonly believed that

the forests of tropical countries are gay with many-coloured orchids and gorgeously flowering creepers. But, so far as the forests of New Guinea are concerned, you may travel for many miles and never see a flower so gaudy as a dandelion. The low-lying country is covered with a very dense jungle of palms (nipa) and pandanus, and occasional big trees tied together by an inextricable tangle of rattans and other creepers; orchids there are in considerable quantities, but they are high up in the trees, and their flowers are mostly small and inconspicuous. In the foothills the only conspicuous plant is a beautiful climber, with clusters of scarlet flowers (*Agalmyla* sp.). It is a very noticeable feature of many of the flowers in the forest of the lower hills that they are red in colour. Between 2000 and 6000 feet the most numerous group are pitcher-plants (nepenthes) and begonias, of which latter many species were found, some of them of great beauty. The most striking plant of all that we saw was found at 5000 feet, a climbing rhododendron with large clusters of flame-coloured flowers. At 6000 feet we found violets (*Viola papuana*) growing. The dense forest characteristic of the lower slopes of the mountains continues almost unchanged, except that rattans disappear at about 4000 feet, until between 7000 and 8000 feet the larger forest trees disappear, and their place is taken by pandanus and tall casuarinas. At about the same altitude there begins to be a marked increase in the number of herbaceous flowering plants, particularly terrestrial orchids (*Giulianetta* sp.) (*Pterostylis* sp.), gentians, geraniums, and other plants of familiar appearance. Between 9000 and 11,000 feet the most conspicuous plants are bushy vacciniums and rhododendrons of several species.* These plants form a very dense bushy jungle, always heavily overgrown with mosses, which is very difficult to traverse; among them grow, up to about 10,500 feet, the curious pine-like trees (*Podocarpus papuanus*). Above 11,000 feet the rocks become so steep that very few plants can grow at all; here and there in the less precipitous places a few rhododendron bushes are found up to about 13,000 feet, above which the only plants found growing were a daisy and a few grasses and mosses.

Zoology.

One of the first objects of the expedition was to obtain natural history specimens, and large collections were made of birds, mammals, reptiles, and insects, the descriptions of which will be published in another place. Mammals are very few and inconspicuous, the only large species being the pig (*Sus papuensis*), which is fairly abundant in the lower hills. The moss forest at about 10,000 feet on Mount Carstensz was traversed in all directions by the well-worn tracks of *Prœchidna*, which must be extremely numerous up there. We saw no signs of the gigantic animal, the so-called gazeka, which has been reported from British New Guinea, nor do I believe

* It may be recorded here that sixteen species of rhododendrons were found in the mountains, all of them new to science.

that it can possibly exist in this region. Of birds, the most remarkable group are the birds of paradise, of which eighteen species were obtained; their highest limit appears to be about 6000 feet. The most abundantly represented groups are parrots and lories, pigeons, flycatchers, and honey-eaters. Reptiles, particularly frogs and lizards, are exceedingly numerous; it is interesting to record that whereas in the Mimika district snakes of many species were found almost daily, here they were very rarely found. Insects, except in the higher parts of the mountains, are found everywhere in large numbers; but, as was said above of the flowers, they are neither so numerous nor so brightly coloured as might be expected. This is particularly true of the Lepidoptera, and more especially of the butterflies, which are mostly very sombre and inconspicuous, and in many places so rare as to be almost non-existent. The scarcity of butterflies is, I believe, mainly due to the heavy rainfall, which is so constant in the neighbourhood of the mountains that the year is practically one long wet season. In British New Guinea and along the north coast of the island there are very definite wet and dry seasons, and in those regions butterflies are very plentiful.

Climate and Health.

From our experience on the Mimika expedition it appeared that the least wet season was from October to April; for that reason we chose September as the best time to enter the country. During the period October 1 to March 31, 52·4 inches of rain fell on 125 days at our base camp. That may be taken to be the normal rainfall in the coastal district during those months. Had we measured the rainfall at any one of our mountain camps, it is probable that double that amount would have been measured, for rain fell every day in the mountains, often in very large quantities. The average *maximum* temperature recorded in a well-sheltered house at the base camp during six months was 84·6° F., and the average *minimum* temperature 74·4° F.

By means of prophylactic doses of quinine malaria was to a great extent avoided; all the cases that occurred were of the "benign" type. It is worth recording that Mr. Van de Water, Mr. Kloss, and I took a daily dose of five grains of quinine bihydrochloride, with the result that neither of us suffered at all from fever while we were in the country.

Six cases, of which one was fatal, occurred of dysentery. There were also a large number of cases of very severe diarrhœa due to eating "umbut," the heart of a native palm-tree; these cases ceased when the men were forbidden to eat that vegetable.

Beri-beri, which was so serious a trouble and caused so many deaths in the Mimika expedition, was happily entirely absent. I had taken the advice of the various experts on the subject, and decided that the best measure to avoid the disease was by the use of red or unpolished rice. Through the kindness of the Dutch authorities, I was permitted to obtain my supply from the Government store at Batavia, and the whole

expedition, Europeans and natives alike, ate that rice and no other, with the result that no man developed even the preliminary symptoms of beriberi. The former expedition was supplied with white polished rice only.

Compared with the Mimika expedition, in the first twelve months of which there was a mortality of twelve per cent., our case was very different. Out of a total force of 226 men, one died of dysentery, one died of fever and complications after an injury, and one man was drowned. Part of this freedom from sickness may be attributed to the rice and part to the comparatively short duration, six and a half months, of our stay in the country. At the end of that time the men had done quite enough hard work in the very trying conditions of New Guinea, and had we stayed much longer the amount of sickness would doubtless have rapidly increased.

Before bringing this paper to a close, I must here publicly offer my thanks, which have already been transmitted officially by the British Foreign Office, to the civil and military authorities of the Netherlands East Indian Government for the generous help they afforded to me in every way, and especially to Lieutenant (now Captain) Van de Water, the commander of our escort; to Mr. C. B. Kloss for his invaluable help in New Guinea, and for the use of many beautiful photographs which have illustrated this paper; to Mr. W. R. Ogilvie-Grant and Mr. C. E. Fagan for their unfailing assistance and advice on this side of the water; and, though they are able neither to read nor to listen to this paper, to those Dyaks and others, through whose muscular exertions we achieved some of the objects of the expedition.

The PRESIDENT (before the paper): Mr. Wollaston was educated at Clifton College and King's College, Cambridge, and is also a member of the Royal College of Surgeons, and a Licentiate of the Royal College of Physicians. He has been an extensive traveller in many parts of the world. He has made excursions into the Sudan, to various islands in the Pacific, and to New Guinea as long ago as 1903–5. He was doctor to the British expedition to Ruwenzori in 1905–7, and also to the expedition to Dutch New Guinea in 1909–11. In 1912–13 he undertook another expedition to Dutch New Guinea, during which he made a first ascent of Mount Carstensz, 11,000 feet high, with two companions, and it is the results of this second expedition which he is going to narrate to us to-night. Mr. Wollaston is a distinguished naturalist, and has done much important work especially in connection with birds. He is, further, the author of two excellent travel-books, one 'From Ruwenzori to the Congo,' and the other 'Pygmies and Papuans,' so that it is, if I may say so, a singularly competent and well-endowed lecturer to whom we are about to listen.

The PRESIDENT (after the paper): Mr. Wollaston mentioned that there was here to-night Mr. Hubrecht, who was on a Dutch expedition in the same region as that explored by Mr. Wollaston himself, and I am sure we should regard it as a great kindness if he would be willing to address us.

Dr. P. F. HUBRECHT: It was with great pleasure that I listened to the very interesting lecture by Mr. Wollaston, who has been exploring in a part of New

INDIRA COL, 20,860 FEET, OR WATER-PARTING AT NORTH SOURCE OF ROSE GLACIER, WITH VIEW NORTH TOWARDS CHINESE TURKESTAN SHOWING THE EASTERN SIDE OF GUSHERBRUM GROUP AND GUSHERBRUM GLACIER RUNNING NORTH-NORTH-EAST.

Guinea only 100 miles away from where we were ourselves. For many days we were wondering where his expedition might be. We had been looking at Mount Carstensz to see whether Mr. Wollaston was on the top. Although we were working so close together I met him only for the first time afterwards in London, and now I am so very happy that he succeeded in reaching that mountain, which one of our navigators saw from the sea three hundred years ago. Wollaston was the first to reach the snow of that peak named after Carstensz. The expedition of Lorentz reached the snow of Mount Wilhelmina, but we are glad that, as it could not be one of our own countrymen, it was an Englishman who reached the snow of Carstensz. It struck me that Mr. Wollaston's expedition was successful, as he fulfilled it with only 90 coolies. I can tell you we had 150, and we found it very difficult; but as he succeeded with only 90 he is all the more to be congratulated. I must congratulate him on one special point—his kind-heartedness to the natives. When you travel in such a country you see these natives, and their habits and customs, and you feel kind-hearted towards them, and that is a point I must specially speak of to-night. When Mr. Wollaston got into difficulties he had their help—he did not mention it—but that is how the Englishman gets on with the natives. That is the first point, that is the principle on which the English nation has always been first in successfully colonizing different parts of the world. Therefore, we are so happy that now it could not be a Dutchman it was an Englishman who reached the snow mountains. May I congratulate the speaker to-night on his success?

Dr. A. C. Haddon: Three groups of hill-men have recently been discovered on the foothills of the Nassau range: the Tapiro, made known to us by the first expedition of the British Ornithologists' Union (1910–11) (A. F. R. Wollaston, 'Pygmies and Papuans,' 1912; Captain C. G. Rawling, 'The Land of the New Guinea Pygmies,' 1913); the Pesegem, discovered by the Lorentz expedition (1909–10) and described by van Nouhuys ('Der Bergstamm Pesegem im Innern von Niederländisch-Neu-Guinea,' in 'Nova Guinea. Résultats de l'Expédition Scientifique néerlandaise à la Nouvelle-Guinée en 1907 et 1909.' Vol. 7, Ethnographie. Livraison i. 1913); and the Utakwa,* of whom we have just been informed by Dr. Wollaston. They are all alike in being of lighter colour than the plainsmen, the Utakwa being the fairest. Their hair is woolly and usually short, with an abundant growth on the face; the hair on the body appears to be variable. The nose seems to be typically flat at the bridge and broad at the wings; the septum is pierced. They further agree in being of short stature. The Tapiro are so short that they may be classed as pygmy, their average height being 1·446 m. (4 feet 9 inches). The Pesegem vary from 1·52 m. to 1·60 m. (4 feet 11 inches to 5 feet 4½ inches), and the Utakwa average 1·533 m. (5 feet ¼ inch) though several are distinctly tall. None of them scarify the skin or tattoo. All build square, or nearly square, houses on piles 5 to 10 feet high. The walls are built of poles by the Tapiro and Utakwa, and of boards by the Pesegem; the roof in all three cases is of palm-leaves, and projects on the door side to form a narrow verandah. There is a single chamber, but in the Pesegem houses the back part is partitioned off for pigs. In all there is a central square fireplace. Each family appears to have its separate house, but the Pesegem have a men's house in each village, which is circular, with a loft in the pointed roof; the men often sleep there, and women are not admitted. This proves a distinct cultural element that is well known in other parts of New Guinea. A small hut, of

* Utakwa is the name of a river, but as we do not know by what name the natives under discussion call themselves, this term may be adopted provisionally for them.

unknown significance, was seen outside the Tapiro village, but nothing of the sort is recorded for the Utakwa.

All three have terrace cultivation, the terraces being held up by logs. They grow sweet potatoes, a few bananas, and a little sugar-cane, taro, and tobacco. It is not stated that the Tapiro keep pigs; the Utakwa possess a few, while they play a great part in the life of the Pesegem, which is a Papuan characteristic.

The stone axes of the Tapiro and Utakwa have a straight handle, the stone being inserted directly in the shaft; but the Pesegem axe has a shoulder, as in other parts of New Guinea. All use the bow and arrow. The bow is simple; the string is kept in place by a band of plaited rattan. There are several kinds of arrows, but only those of the Pesegem are barbed. Spears are absent. All use stone knives, but these are commonest among the Utakwa. All make fire by means of a split stick on which a strip of rattan is rubbed. In an appendix to Dr. Wollaston's book I said, "it is possible that the split stick and rattan strip method of fire-making may be a criterion of Negrito culture" (*l.c.*, p. 318). All smoke cigarettes, but also use simple pipes of varied construction. All make string bags with the same kind of stitch. The men wear belts of rattan, and carry a rain-hood of pandanus-leaf in their bags. The Utakwa carry a small rectangular wooden shield, which is definitely absent from the Pesegem and apparently also from the Tapiro. Necklaces, etc., are worn; they vary a good deal, but some types are common to all three. The gourd penis-case is worn by all. The Tapiro and Utakwa have the jew's-harp, but it is not recorded for the Pesegem, though they probably have it. The Tapiro rub bones together to make a squeaking noise.

Nothing is known of the social life or customs of any of these small hill-men, except that the Tapiro have a definite leader; but this is not the case with the Pesegem or the Utakwa.

The method of burial of the Utakwa is by inhumation; the body is usually tied in a sitting position and lowered into a round hole about 4 feet deep. The method of the disposal of the dead by the Tapiro and Pesegem has not been recorded.

Van Nouhuys states that the Pesegem gave the impression of being a mixed race, varying greatly in height and in physical appearance. This is borne out by their culture, and, indeed, it seems also to be true to a certain extent of the other two peoples under consideration. Nevertheless, there does seem to be a substratum common to the three peoples, and this we may term provisionally Negrito.

Dr. H. O. Forbes: I do not know that I have very much to say, except to congratulate Dr. Wollaston on the success of his expedition. It is now some five-and-thirty years since I first looked on the summit of the Carstenz range from the sea, very much hoping that some day I might be able to get there. At that period, however, it was supposed to be barred by obstacles too difficult to overcome. If one lives long enough, one sees many impossibilities resolve themselves, and I feel great pleasure, therefore, in having to congratulate my friend on having overcome them and reaching the snows—a splendid achievement. There are few here to-night, perhaps, who can realize and appreciate more fully than I the difficulties, anxieties, discomforts and dangers which he has surpassed, and which he has touched on so lightly to-night; for it was my fortune to have to find my way further south in the British territory along the bed of such a river as formed Dr. Wollaston's highway.

It is not easy for an explorer, attired in immaculate evening costume, looking as if he had never been out of Piccadilly, to bring home to an audience comfortably seated and post-prandially pleasant and content, all that is meant by

a river-road full of dangerous rapids and unfordable pot-holes, hedged in by precipitous cliffs, bordered by pathless jungle full of mosquitos, flies, leeches, and thorns; the night-hours passed in a freezing atmosphere in sodden clothes, short of rations, depressed by the all-obliterating mists; the boatwrecks; the loss of the irreplaceable records of an arduous adventure. The vocabulary to express in exact terms or to present to those who "sit at home at ease" any real picture of such experiences—be they in the tropic or arctic regions—as Dr. Wollaston mildly describes as "trying to his Christian patience," has not yet been invented. It is too often forgotten, when an explorer fails of attaining the whole of what he sets out to accomplish, that his best-calculated efforts and most strenuous fights must inevitably fail against the omnipotency of Nature when she is in opposition. He only succeeds in his desperate attempts to penetrate her strongly-guarded secrets when she is in amiable and benign mood and non-resistant. Dr. Wollaston's achievement, if this audience could fully realize it, is a first-class piece of exploration splendidly engineered.

Mr. Henry Balfour: As Dr. Haddon has already intimated, ethnologists will be looking for further details from Mr. Wollaston, because he has touched upon a very interesting point in connection with the racial divisions of the population. More especially interesting is the Negritic element in New Guinea, which is gradually being traced over a wider and wider area as British explorers investigate new districts, and I can only hope that when Mr. Wollaston's field-notes come to be written up, there will be more information forthcoming which will help to link up the several peoples showing Negritic affinities from west to east in New Guinea. One point referred to was the occurrence on the upper waters of the rivers of the Mount Carstensz region of the same method of fire-making as had been found already amongst the Tapiro pygmies on the former expedition, and which has been discovered sporadically through New Guinea eastward into German territory, but nearly always either associated with the Negritic tribes themselves, or occurring in their more or less immediate neighbourhood; and this particular method has been traced now pretty well all the way from as far north and west as Assam to the Philippines and eastern New Guinea, and I have no doubt this forms a perfectly *connected* area of dispersal, and that the method is traceable to one common origin. I trust that ethnologists will in future be able to settle the ethnological significance not only of a single point such as I have mentioned, but also of numerous other correspondences in the culture of the peoples throughout this very wide region. I hope that Mr. Wollaston will have further evidence to report on the culture of these upland people more especially. I congratulate him most heartily on his very great success, not only as a geographical explorer, but also as an ethnologist, botanist, and zoologist.

The President: No more agreeable task lies before the President of this Society than when, at the end of a meeting, he is called upon, in discharge of his duties, to be the means of conveying the thanks of the audience to a capable lecturer; and certainly on no occasion has the task been pleasanter, because, among the many lectures I have listened to here, I do not think I ever heard one at the same time more adventurous, more entertaining, or more striking than that to which we have listened. I should like to join the lecturer in our expression of thanks to the Dutch Government for the courtesy that they showed him; it is clear from his narrative that the most agreeable relations of friendship and co-operation existed throughout between the two parties. We heard later the pleasant tribute paid by Dr. Hubrecht to the lecturer, and I am only sorry that the gap of 100 miles that separated these two ardent explorers was not

bridged by good fortune, and that they did not conduct their expeditions together. However, inquiries which I have been making of Dr. Wollaston lead me to think that the spirit of adventure in him in relation to New Guinea is by no means exhausted, and that the man who on one occasion has looked at Carstensz from the lower regions, and then later has climbed up its rather forbidding sides, and only been stopped by an ice wall from getting to the top, is not in the least likely to be dissuaded from the ambition of reaching the summit; and therefore, though it may not come in my term of office, I entertain little doubt that before very long an audience will be assembled in this hall as large—it could not be larger—to hear of a successful attack made by Mr. Wollaston on that hitherto inaccessible peak. May I join one of the previous speakers in saying that it is always with special pleasure that we listen to the narrative of a man representing our race, who in his work, under difficult circumstances and among strange peoples, has the art of ingratiating himself with the natives and showing kindness and warmth of sentiment towards them. It is quite clear that Mr. Wollaston is such a man, and from his narrative it was evident to us how much his heart was touched by the sad spectacle presented by the mortality among those poor people. However, the main point of view that affects us, meeting here, is that not of sentiment, but of addition to human knowledge; and I claim for the paper to which we have listened, that both in the form in which it was delivered and still more in that in which it will be published, it makes a substantial addition to science, and notably to the science of ethnology. I hope, therefore, that you will allow me on your behalf to convey our thanks to Mr. Wollaston for his paper.

Prof. Edgeworth David, F.R.S., sends the following note on Mr. Wollaston's paper:—

With regard to the hot saline spring with its sulphuruous waters, described by Mr. Wollaston on his route up the Utakwa river to Mount Carstensz, Prof. David considers that this spring was very likely connected with the great oil-bearing belt of New Guinea. This belt had now been proved to extend, at intervals, all the way from Burma through Sumatra, Java, and Timor into Dutch and British New Guinea. The indications of the existence of extensive oil deposits in British New Guinea were extremely good, and the Commonwealth Government was at present engaged in testing the deposits by boring, with, so far, favourable results. The chief evidence of the existence of the oil belt in British New Guinea was afforded by springs yielding saline and sulphurous waters through which natural gas was continually bubbling. The appearance of the spring visited by Mr. Wollaston was extremely like that of the springs of the oil-field in British New Guinea, and if it really indicated the presence of oil, as seemed probable, it would prove an important link for joining up the oil-field of the west part of Dutch New Guinea with that of the Gulf of Papua in British New Guinea. He points out that the evidence brought forward in Mr. Wollaston's valuable and interesting paper agreed with that obtained in British New Guinea in showing that the main ranges of New Guinea were overfolded, and that the overfolds, like those of the Himalayas with which the New Guinea folds were probably tectonically connected, were directed southwards—that is, against the resistant massif of the Australian continent, as were the folds of the Himalayas against the massif of Peninsular India.

Major Rawling sends the following statement:—

I congratulate my old comrade on his splendid piece of exploration—splendid it certainly is, for no more formidable country exists upon the face of

the globe. It only shows what can be accomplished with perseverance and first-rate organization. The mountain men apparently subsist entirely upon their plantations; but how they originally reached the district they are now in, unless their antiquity is immense, is a mystery. That they are acquainted with the Tapiro pygmies, discovered by the Mimika Expedition, is clear by the similarity of dress, ornaments, architecture, and weapons of the chase, and still more so by the fact that they can count up to ten—a feat of arithmetic far beyond the powers of the plainsmen. Since the two tribes are so alike in these points, I think we may presume that the women of the Tapiro pygmies, of whom we failed to obtain a glimpse, are in like manner clothed in a girdle of leaves. Their bodily characteristics, however, are so dissimilar that it will not be easy for anthropologists to connect the two, and it raises one more conundrum which scientific men will find it hard to solve. I am glad that Mr. Wollaston has been able to bring forward further evidence of the terrific steepness and immensity of the southern face of the main range, and, in addition, has been able to obtain a telephoto of the precipice to the south of Mount Leonard Darwin. Mr. Wollaston still considers it possible that mountains of even greater altitude lie to the north of Mount Carstensz, and we must all sympathize with him in his disappointment at being baulked of his wish at the last moment; but in my own mind I am more convinced than ever, now that I have seen the photographs and have looked into the strata of the rocks, that the country to the north consists of great parallel ranges, steadily dwindling in altitude and with no peak surpassing Mount Carstensz in height.

PHYSICAL CHARACTERISTICS OF THE SIACHEN BASIN AND GLACIER-SYSTEM.*

By WILLIAM HUNTER WORKMAN, M.A., M.D., F.R.G.S.

THE term "glacier" is not sufficiently comprehensive to designate accurately the immense and, in arrangement, complicated bodies of snow, *névé*, and ice collected in the great rock-basin extending north-west from the source of the Nubra river to Peak 23 (Hidden peak), 78·4 kilom. (49 miles), with an east and west average width for a considerable distance of 32 kilom. (20 miles), and having an area, approximately, of 2400 sq. kilom. (over 900 square miles).

The basin is crossed in various directions by many glaciers of the first order and innumerable lesser ones, fed by snow precipitated upon the mountains and slopes of its watershed, all converging on a great central trunk averaging 4 kilom. (2·5 miles) in width, that stretches the length of the basin in a north-west by south-east direction and discharges from its tongue water derived from the snow collected in all parts of this extensive region to give birth to the Nubra river. This central trunk with its multitude of affluents resembling a river-system is more fittingly styled the Siachen glacier-system. The four other great Karakoram glaciers, as well as many smaller but by no means insignificant ones, are fashioned on the

* Royal Geographical Society, November 24, 1913. Map, p. 232. Read after the paper on the same date by Mrs. Bullock Workman. For discussion, see p. 142.

same plan. This type is peculiar to the Karakoram, being conditioned on the configuration of its valleys and the arrangement of its peaks. For this reason, as well as on account of certain structural features referable to existing conditions, all these glaciers merit the designation of glacier-systems or glaciers of the Karakoram type.

The Siachen basin is separated by its enclosing walls, on the east, from an unexplored region containing the Remo basin, with which the Siachen probably communicates by an ice-covered pass, possibly two, leading from the head of the Tarim Shehr affluent, and further north a group of snow mountains discovered by us from the east Siachen head that give rise to a large glacier, apparently the Urdok, running north-west into Chinese Turkestan; at the north end, from a glacier-basin leading north-east from the Gasherbrum massif; and on the west from the Baltoro, Kabery (Kondus), Sher-pi-gang, Dong Dong, Bilaphond, and Chumik basins, with glacier-passes connecting with the Bilaphond and Kabery, the last first discovered and crossed by our expedition in 1912.

The enclosing barriers of the Siachen consist of granite, gneiss, crystalline schists, slates and shales, sandstones, amorphous and crystalline limestones, and conglomerates, with some igneous intrusions. These rocks alternate with one another at short intervals, and are in places intimately intermingled and interfolded. They are extensively foliated, friable, and easily disintegrated by frost and weathering. Even the granites, largely of the biotite variety, are divided into small sections by joints crossing one another, and intersected by bands of quartz, feldspar, schists, and shales, in consequence of which they split up easily into fragments. The physical condition of the gneiss and crystalline schists would suggest to the ordinary observer that they were formed largely by metamorphosis of sedimentary deposits. But whether this be the fact, or whether it be that they originated as primary granites and were afterwards metamorphosed by folding, they are brittle, and present in the one case an immature appearance as if incompletely developed, or in the other a decadent one, as if the original structure had been overwrought and disorganized by strain and violence in the upheaval of the great ranges of which they form constituents.

This fragile condition of the rocks accounts for the irregular, jagged outlines of the mountains of the region, especially of the granite peaks, many of which are greatly serrated, and for the vast detritus-deposits that load the glaciers and play an important rôle in the development of their structural features. Owing to the amount of snow covering the mountains and the staining and weathering of the visible rock-surfaces, it is often difficult, even from a short distance, to distinguish the character of the rocks composing a mountain, so that the observer, particularly if he is not a trained geologist, may well be in doubt as to what formation lies before him. The shales and slates, the latter largely of very dark colour, are the most easily distinguished.

The north-east wall of the Siachen trunk resembles in structure and extent that which, with an unbroken length of 63 kilom. (39 miles), forms the upper portions of the southern Hispar and western Biafo barriers.* Starting at the north-east head, it extends west 4·8 kilom. (3 miles), then turns south-east and continues on 22 kilom. (14 miles) to the Tarim Shehr affluent. Here it turns east and forms the north wall of the Tarim Shehr for 27 kilom. (17 miles) to its sources, making a continuous, unbroken wall 53 kilom. (33 miles) long. The upper 20 kilom. (12 miles) of this wall is, and the remainder appears to be, a part of the main watershed between Turkestan and the Indus, and as such it probably continues on from the head of Tarim Shehr tributary to the Karakoram pass.

A second portion continuing around as the south wall of the Tarim Shehr glacier and extending west to the Tarim Shehr promontory there turns south-east and forms the remaining portion of the north-east wall of the trunk to its end, having a length of 53 kilom. (33 miles). Stated in another way, the north-east Siachen wall stretches from the north head of the trunk south-east in a nearly straight line for some 72 kilom. (45 miles), being pierced only by one small and two large affluents.

The south-west boundary of the upper half of the trunk can scarcely be called a wall. It consists of numerous mountains of irregular outlines, scattered about in an irregular manner, enclosing vast reservoirs of snow and ice that communicate with the main glacier by large secondary glaciers, the whole forming an ice-bound labyrinth that defies description. Still, the mountains and affluents stand in such relation to the main glacier that lines drawn from one headland to another suffice to mark the limits of its bed with sufficient accuracy. From the Peak 36 tributary to the tongue, a fairly continuous wall exists which is pierced by several large affluents.

The structure of these walls may be stated in general terms as follows †: The mountains enclosing the Indira Col and the north-east col, at the northern extremity, are composed of slates and shales, light and dark in colour with, possibly, some limestones. Thence down the north-east wall to within about 6 kilom. (4 miles) of the Tarim Shehr opening mostly of light coloured limestones and shales with some conglomerates and at least one igneous intrusion. The limestones are strongly in evidence in the moraines fed by this section. The rocks are soft and the peaks and ridges broken and jagged in outline. From a point shortly north-west of Teram Kangri, the wall and its peaks, including that summit, quite to their tops, forming the north barrier of Tarim Shehr glacier to its end, appear to be almost wholly made up of black slate with here and there foothills of lighter-coloured shale or limestone.

* Vide *Geographical Journal*, February, 1910, p. 117.

† It is obvious that not more than a general outline of rock distribution could be obtained amid the exigencies of an expedition of limited duration, with opportunities for investigation restricted by snow and weather-conditions, in an unexplored region of such character and extent as the Siachen basin, where one can come into actual contact with the rocks *in situ* at comparatively few points.

The same is true of the visible rocks on the south side of Tarim Shehr glacier, though some of the ice-covered peaks at its upper end must contain granite and gneiss, as much *débris* of this character appears in the moraines of that side. On the extremity of Tarim Shehr promontory, most of which is composed of brown shale, granite crops out over a considerable area. Thence, beginning with Junction mountain, 6353 metres (20,840 feet), rising above the promontory, ascended by us in 1911, down to the great bend, some 25 kilom. (16 miles), the mountains are of dark brown and black slate with occasional sections of lighter colour broken into jagged points and cleft by deep, ragged ravines. The only granite noticed *in situ* in the whole length of this wall was at Tarim Shehr promontory.

From our camps on moraines opposite this wall, the view toward it was most forbidding. The foreground was occupied by the huge black hillock-moraine coming from the Tarim Shehr affluent, the towering hillocks of which, resembling vast heaps of coal piled up at random in a Cyclopean coalyard, shut out from sight the white ice of the glacier beyond, while the background was formed by the succession of black peaks hard in outline and destitute of grace, rendered more desolate by contrast with the snow capping their tops, the whole constituting as sombre and depressing a landscape as could well be imagined, far eclipsing the most fantastic conceptions of Boecklin and casting an uncanny shadow over the soul.

On the south-west side of the trunk a similar variety of formation occurs, but granite is more and limestone less in evidence. The last three peaks of the King George V. group ending the massive mountain-tongue, interposed between the heads of the Baltoro and Siachen glaciers, which form 11 kilom. (7 miles) of the upper south-west Siachen wall, appear to be mainly composed of granite and gneiss, though on an eastern spur and near its south-east extremity the granite passes over suddenly without discontinuity of outline into black slate.

South of this tongue at the entrance of the upper western tributary into the Siachen, the Hawk, a graceful pointed spire of granite, soars from a circle of black slate peaks and ridges to an altitude of 6768 metres (22,200 feet). From this peak downward for 35 kilom. (22 miles) to the great bend, the south-west wall is largely, if not wholly, composed of sedimentary rocks, prominent among which are black slates. Just at the bend, two elevations, the ends of spurs descending from Peak 8, have the appearance of granite. The greater part of the south-west wall, as we observed it, does not, therefore, conform to the granite structure assigned to it by Dr. Longstaff.

Sixteen kilometres (10 miles) west of the trunk the impressive granite massif of the twin Peaks 35 and 36, 7743 and 7707 metres (25,400 and 25,280 feet) overtopping all mountains of the region south of Peak 23 and forming a salient landmark, gives off the large Peak 36 affluent to the Siachen on the east and the Dong Dong glacier on the west. Granite and

FIG. 3.—TWO GIGANTIC SERACS AND PASSAGE BETWEEN THEM ON SIACHEN. LARGE AREA OF SIACHEN SURFACE AT AND BELOW TARIM SHEHR JUNCTION BROKEN UP BY PRESSURE IN THIS MANNER.

FIG. 4.—CONVERGING BLACK AND GREY MORAINE STREAMS COMING TOGETHER AND STRANGLING IN THEIR GRIP ATTENUATED EXTREMITY OF WHITE STREAM. PROPORTIONS OF LAST DISTORTED BY POSITION OF CAMERA. WIDTH IN FOREGROUND, 10 METRES (32·8 FEET). LENGTH TO APEX, 60 METRES (ABOUT 200 FEET). NOTE THAT MORAINE-STREAMS CONTINUE ON WITHOUT INTERMINGLING.

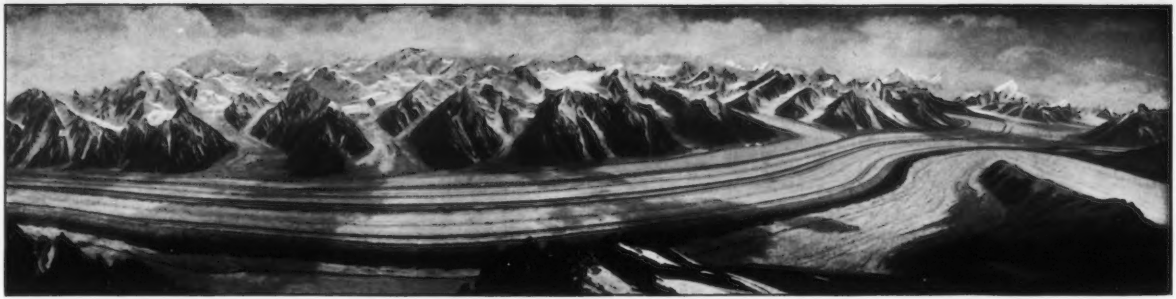


FIG. 1.—BIRD'S-EYE VIEW OF 48 KILOMETRES (30 MILES) OF TRUNK OF SIACHEN GLACIER, SHOWING WHITE AND MORAINE STREAMS, THE NARROWING OF FORMER AND INCREASE IN SIZE OF LATTER AS THEY DESCEND, AND DEFLECTION OF BOTH BY AFFLUENT PRESSURE. AT LOWER RIGHT-HAND CORNER TARIM SHEHR AFFLUENT ENTERS, TURNING THROUGH ANGLE OF 140° AROUND POINT OF ROCK PROMONTORY, FLANKED BY MARGINAL BLACK SLATE MORAINE, WHICH, BENDING AROUND IN SYMMETRICAL CURVE TOWARDS CENTRE OF SIACHEN, DESCENDS AS MEDIAN MORAINE.

FIG. 2.—SECTION OF BLACK SLATE HILLOCK-MORAINE WHICH, DESCENDING TARIM SHEHR GLACIER AS MARGINAL MORAINE, CONTINUES ON DOWN SIACHEN AS MEDIAN MORAINE, HAVING TOTAL LENGTH OF SOME 50 KILOMETRES (31 MILES). ITS HILLOCKS, SEVERAL ABREAST, RISE 100 TO 150 METRES (328 TO 392 FEET) ABOVE DEPRESSIONS AT THEIR BASES. WIDTH APPROACHES HALF KILOMETRE (ABOUT 1600 FEET).

FIG. 7.—PYRAMIDAL ICE-PINNACLES, LAST REMNANTS OF EXTINCT WHITE STREAM, FORMED BY MELTING AWAY OF SOFTER PARTS OF HIGH ICE-RIDGE CROWDED UP BY PRESSURE, AND CUTTING DOWN THROUGH RIDGE OF THIN DÉBRIS-DEPOSITS HEATED BY SUN. DÉBRIS-COVERED SURFACE AROUND PINNACLES FREE FROM CREVASSES. HEIGHT OF HIGHEST PYRAMIDS 11 METRES (36 FEET).

gneissoid rocks crop out, doubtless, at various other points of the Siachen basin that were not within range of observation. No conglomerates *in situ* were noticed.

Thus it will be seen that, while slates and shales constitute, perhaps, the greater part of the rocks of this region, they have mingled with them a very considerable proportion of limestones and conglomerates appearing in the moraines, and also of granite, gneiss, and crystalline schists. No single formation continues uninterrupted for any great distance. One mountain may be of granite and the next of shale or limestone, or the same mountain may consist of two or more rock-varieties more or less intimately mingled. This composite arrangement, as I have had opportunity to observe in an almost continuous line from the Siachen to Hunza, exists throughout the Karakoram. The opposing walls of its valleys, large and small, both those running east and west and those north and south, are often composed of different varieties of rocks, perhaps granite on one side and shale or other sedimentary rock on the other, or a given wall may vary at different points in the same manner. The various rock-formations not only of the Siachen region, but also everywhere that I have been in the Karakoram, are so distributed and intermingled that it does not appear to me possible to draw any reliable inference from them as to the existence of parallel ranges of dissimilar structure.

In the June, 1910, *Geographical Journal*, p. 646, Dr. Longstaff states that the Duke of the Abruzzi's expedition discovered that "this (Broad peak) and the four Gasherbrums are composed of marbles and conglomerates." He adds, "The massif of Teram Kangri is a continuation of this (Gasherbrum) range; its base appears to consist of schists and slates and its peaks of marbles and calcites." After careful study of the published accounts of the expedition referred to, I have been unable to find any authorization for the statement that Broad peak and "the four Gasherbrums are composed of marbles and conglomerates." In the December, 1910, *Alpine Journal*, p. 344, Dr. de Filippi states that moraines seen on the Baltoro "consist of beautiful polychrome marbles and conglomerates, originating from Hidden peak and the Golden Throne," but this is far from "discovering" that Hidden peak, as a mass, and still less the other three Gasherbrums are composed of such rocks.

As already stated, the last three high mountains of the King George V. group, ending the spur and interposed in direct line between the Gasherbrums and Teram Kangri, appear to consist mainly of granite and gneissoid rocks. We passed directly beneath and camped almost in the shadow of the high vertical precipices of their eastern and southern flanks, of which we had a near view. Also the upper portions of the Gasherbrum peaks, as seen from the high Silver Throne plateau to the south-east, appeared to have the shape and general aspect of granite peaks, though we were not sufficiently near them to distinguish their structure. However this may be, we saw nothing in their appearance to suggest marbles.

Regarding the massif of Teram Kangri, having passed three weeks altogether at various points near and in front of it during late summer, both in 1911 and 1912, when the snow was largely melted away, we had considerable opportunity to study it. As we saw it, it appeared to consist of black slate quite to its top, and no evidence of the existence on it or any of the adjoining peaks of " marbles and calcites " could be detected with a powerful field glass. Further, no calcite or marble was found on moraines the origin of which could be traced to Teram Kangri, which does, however, throw off an immense quantity of black *débris* upon the glacier. Therefore the argument based on similarity of structure in support of the view that the massif of Teram Kangri is a continuation of the Gasherbrum " range," so far as can be judged from our observation, falls to the ground.

The topographical objection to this view is quite as strong, if trend and continuity of elevation are criteria, in determining whether two mountain sections are parts of the same range. The Gasherbrum " range," if the comparatively short south-east spur from which Broad peak, the Gasherbrums, and the three last peaks rise can be called a range, ends abruptly in the icefields of the upper Siachen, and has no connection above the ice with the north-east Siachen wall, of which Teram Kangri forms a point, being separated from it at every part by the whole width of the glacier.

On the contrary, the north-east wall continues on directly over the Indira Col at the north Siachen head into Turkestan, with a precipitous drop of *circa* 2000 metres (6562 feet) at the col, running thence north-east as a line of pointed, ragged, dark, slaty peaks, which form the south-east wall of the Gasherbrum glacier issuing from the Gasherbrum peaks. This wall, taken as a whole, constitutes the eastern barrier of an Oprang-Nubra depression, of which the highest point occurs at the Siachen head on the watershed between the Indus and Turkestan, whence the gradient drops north-east toward the Oprang and south-east to Nubra.

The discussion by Dr. de Filippi in " Karakoram and Western Himalaya " of the structure of Broad peak and the Gasherbrums involves the, geologically, interesting and important question touched upon in the preceding pages of the distribution of rocks in this region. On page 227, he says, " From an examination of the moraines that have their origin in the various mountains, we were able to ascertain that the whole chain of Broad peak and the Gasherbrums, including Hidden peak and the Golden Throne as well, is a sedimentary formation."

Not having seen Broad peak or the western faces of the three northern Gasherbrums, which rise from the spur extending south-east from the north Baltoro wall and ending among the upper reservoirs of the Siachen, I would not venture to assert that Dr. de Filippi's inference regarding their structure is not correct, but analysis of the evidence on which it is based does not appear to me to warrant so positive a statement as he makes.

With due deference to the interesting and able treatment by Ing. Novarese of the material supplied by the expedition, although some of the geographical deductions based on it were shown by our later Siachen expedition to disagree with actual conformation, I would ask geological experts, whether a definite conclusion as to the structure of the great inaccessible peaks far removed from direct inspection forming the central and highest portions of the mountains mentioned could be drawn from moraine material lying at a distance on the Baltoro? Might not the sedimentary *débris* here found originate largely or wholly in the lower, outer buttresses of the massifs, or in the outlying mountains between them and the Baltoro forming the immediate walls of the latter? Because such *débris* existed in moraines extending out from these peripheral elevations, does it follow that granite or gneissoid rocks can be excluded as components of the high central uplifts beyond?

My reasons for asking these questions are the following:—

(1) It is a fact which may be observed almost anywhere in the Karakoram, and nowhere more than in this region, that a mountain may be composed of different varieties of rock, the central portions being, perhaps, of one variety and the peripheral of another or several varieties. This is well illustrated in the very spur in question by Queen Mary peak, Mount Hardinge, and the last peak ending it, which consist, apparently, chiefly of granite and gneiss with outlying sections of black slate; by the marble peak on the Baltoro opposite Broad peak, mentioned by Dr. de Filippi as rising from a mass of black rock in the midst of a granite region; and again a short distance south-east on the Siachen by the sharp, grey granite crest of the Hawk towering above a surrounding mass of black slate mountains.

(2) It is also a fact, which I have noticed in various Karakoram localities, that a large surface-moraine may originate in a rock-shoulder or section intercalated in a formation of wholly different character, so that an opinion based on the *débris* found in the moraine might assign to a large massif a formation entirely foreign to that of its greater part and thus be wide of the truth. Moraine *débris*, as such, demonstrates the existence of given rocks without indicating their location or extent. It can only have a positive value in determining the distribution of those rocks when traced to the sources from which it springs. The sedimentary *débris*, found by Dr. de Filippi on the Baltoro moraines, shows that sedimentary rocks exist in the mountains at the head of the glacier, but it does not indicate their exact location or limits, nor does it exclude the presence in these mountains of other rocks. His account does not make it clear whether these moraines do not contain also granitic *débris*, as would appear probable from Conway's earlier observations. The sources of these moraines seem to have been judged of, chiefly, by their trend towards the bases of certain mountains, but it is evident that the *debris* on them was not and could not be traced to an origin in the central highest peaks far

behind. Further, in the above quotation he includes among the peaks, the structure of which he "ascertained" from examination of these moraines, Gasherbrum II. and III., which, according to the map published with his book as well as those of Sir Martin Conway and the Indian Survey, have no direct connection with the Baltoro, and from which, therefore, no *débris* of any description can reach the Baltoro moraines.

(3) Dr. de Filippi mentions the grey colour of the higher parts of Broad peak and the Gasherbrums as distinctive of limestone. The colour of the three last granite or gneissoid peaks of this spur is also grey. This colour, in the presence of Himalayan weathering, is at least as characteristic of granite as of limestone.

(4) Also the broad strata of Broad peak, cited as distinctive of sedimentary rocks, are very commonly seen in Himalayan granite, gneiss, and crystalline schists. The face of K2 asserted to be a granite massif presents in panorama E. of "K. and W. Himalaya," an appearance very like that of a banded formation.

(5) Likewise the forms of the compact pyramids or obtuse cones with smooth outlines of Peak 23, and the other three Gasherbrums strongly resembling those of granite spires in the Bilaphond, Kabery, and Saltoro regions, suggest granite quite as much as sedimentary formations, as do also the rounded summits of Broad peak as seen in the Sella panoramas. The summits of Broad peak parallel closely in shape those shown of its next northern neighbour, Staircase peak, stated by Dr. de Filippi to be granite, *cf.* panoramas C and G. As granite appears to form the mass of the three south-east peaks of the same spur on the other side, according to Dr. de Filippi's inference Broad peak and the Gasherbrums are a *high sedimentary group* flanked on either side by *lower granite mountains*, the first exception, I believe, reported to the rule enunciated by the Indian Geological Survey that the upper portions of very high Himalayan peaks are of granite. Can this inference as to structure be accepted on the evidence given?

From these considerations, without expressing a positive opinion, I would suggest as an alternative proposition for investigation by future explorers, particularly geologists, who may have opportunity to examine this region more carefully, that the whole spur heading the Baltoro on the east from Staircase peak, so called, to its termination in the snows of the Siachen consists of a lofty central vertebra of granite and gneissoid rocks flanked on both sides by lower sedimentary slates and limestones, which last form the source of the limestone *débris* found by Dr. de Filippi in the Baltoro moraines and of similar *débris* observed by our expedition in 1912 on the Kabery glacier moraines south of the Golden Throne.

The great altitude of the mountains and ridges surrounding the heads of the Siachen, and spread over the region west of it almost to the extremity of its tongue, ensures the accumulation of enormous quantities of snow upon them and in the labyrinthine recesses between. The whole region

for many kilometres back from the main glacier constitutes a great reservoir, that sends forth its icy contents by affluent after affluent to build one large central trunk. The north-east wall, much less ice-clad than the south Hispar wall, contributes a relatively small quantity of ice to the trunk, but the ice-streams from it are loaded with a vast amount of rock-detritus from its crumbling crags, which deposited upon the glacier exercises an important influence on the glacier-economy. Through this wall, about midway between its ends, enters from the east the largest affluent, the Tarim Shehr, contributing to the main glacier ice from a wide eastern area.

The ice thus poured into the main trunk is sufficient to keep it at a maximum volume so as to cover completely the floor of the valley it occupies, leaving no free space between it and the valley-walls. No passage exists by the side of the glacier or over the precipitous valley-walls. The explorer is obliged to find his way over the glacier itself, an undertaking as arduous and dangerous as the ascent of high snow-clad mountains, the nature of which is not appreciated by those unacquainted with Himalayan glaciers. In this respect the Siachen resembles the Kondus system of glaciers, but differs from the Biafo and Chogo Lungma, which do not fill their valleys. These last can be penetrated for long distances by the sides of the glaciers upon lateral moraines or over maidans and slopes covered with grasses and flowers.

A bird's-eye view of the Siachen trunk from Junction mountain above Tarim Shehr, 6353 metres (20,840 feet), shows it to be composed of a number of sharply defined, parallel, longitudinal sections or streams, some consisting of white ice, others covered with moraine material, running side by side for many kilometres, the largest for above 50 (30 miles) without intermingling. These I will distinguish from one another in this paper by the names white and moraine-streams from their surface appearance, and I will also apply the term "white ice" to those parts of the glacier which were comparatively free from detritus without regard to the physical distinction between surface white ice and the blue or black ice of the glacier-body beneath.

These streams, which can be traced upward toward the ultimate sources of the trunk and affluents, are seen to represent the ice-masses contributed by the initial reservoirs compressed and narrowed into ribbon-like bands by the tremendous lateral pressure developed by the crowding of vast bodies of ice coming from different directions into the comparatively small space between the mountain walls occupied by the trunk.

This lateral pressure is increased by the entrance of each successive affluent. Any affluent sufficiently large and powerful to add its own streams to those already existing in the trunk must do so by crowding the trunk out of its path over toward the opposite side of the glacier-bed and by inserting its own streams into the side-space thus created. This yielding of the trunk, which previously to the entrance of the affluent completely

filled its bed, is an indication of an increase of lateral pressure proportioned to the size of the affluent, which must result in a further compression and narrowing of the trunk-streams. This is seen in the bird's-eye view to be exactly what happens to the Siachen streams, especially the white streams, which, broad and greatly exceeding the moraine-streams in width in the upper parts of the trunk, gradually become narrowed under lateral pressure until they finally die out and disappear at various distances from their sources.

Pressure is not, however, the only factor involved in this result. Descending to the glacier and crossing it at points above the Tarim Shehr junction, where its surface is fairly smooth, one finds the centres of its white streams in transverse section elevated considerably above their edges, and the streams themselves symmetrically arched or crowned so as to resemble a series of perfectly constructed, metalled, and crowned roadways placed side by side. So high is this crowning that, standing on moraine-ridges in the centre of the trunk, 6 to 10 metres (20 to 33 feet) above the adjoining white ice, I could not see the edges of the glacier on the sides nor, perhaps, halfway to them.

This crowning is connected with the thinning and disappearance of white streams. Its presence indicates that the pressure which diminishes their width also crowds them upward without disorganizing their structure or causing them to mingle with one another, and that, the lateral pressure being applied on both sides, their ice yields most along the central line, which is thus crowded highest. Rapid ablation of the raised portions occurs through melting, which, on this glacier, is very marked in the course of a summer. Ten metres is probably a conservative estimate of its amount. This diminishes the depth and volume of the stream, with the result that it becomes constantly less resistant to pressure and more easily compressed and elevated. The interplay of lateral pressure and ablation, finally, so reduces the size of the stream that it is unable to offer further resistance, and is strangled in the grasp of its more powerful neighbours (moraine-streams), disappearing henceforth from view.*

As the streams become thinner and weaker they are pressed up higher with more abrupt sides, and their tops are broken into superficial séracs, as occurs on the Tarim Shehr and lower portion of the Siachen. Symmetrical crowning here disappears. Crowning can, on the contrary, be traced upward into the reservoirs, where I observed it among the vast snow and ice expanses at altitudes of 6400 metres (21,000 feet). The greater the width and volume of streams and reservoirs the more generally are the effects of pressure diffused throughout the mass and the more gradual are the resulting curves. In the reservoirs, crowning displayed itself in wide elevated ridges sloping gently away to lower levels, orienting

* For a detailed consideration of pressure-effects *vide* "Features of Karakoram Glaciers connected with Pressure," Workman, *Zeitschrift für Gletscherkunde*, Dec., 1913.

at right angles to the direction of pressure. It is easy to understand how here vast masses of snow and ice descending the steep opposite sides of a narrow valley and meeting at the central line would crown upward.

With moraine-streams the case is quite different. They, usually, first appear as small accumulations of *dêbris* at places where *névé* has melted mostly or wholly away, but they increase in size and height as they move down a glacier, till at length they exceed in volume the white streams between them. Those occupying the glacier-edges constitute latero-median or marginal moraines, but when, after coming in contact with affluents, they are pushed away from the edges toward the centre they become median moraines, affluent streams being interposed between them and the sides of the glacier-bed. They increase in size not only through their mass below the surface, being crowded higher by increasing lateral pressure, but also through union with them of marginal moraines of incoming affluents.

Relatively to the white streams, their visible portion becomes also constantly greater from the fact that, being heavily covered with *dêbris*, ablation of their substance through melting is reduced to a very small amount, so that they, practically, retain the elevation and bulk they receive through pressure, while the rapid lowering of the surface and diminution in volume of the adjoining white streams through melting expose a still greater extent of their sides and actually add to the difference in height between the two. As a result, the moraine-streams, which at their points of emergence in the upper parts of a glacier may be on a level with the white, soon acquire a decided elevation above them, which, lower down on the glacier, may become as great as 100 metres (328 feet) or over. Further, as the glacier-bed narrows, the moraine-streams under the influence of lateral pressure thus occasioned converge upon one another, occupying the space left vacant by the wasting white streams, till they come together and swallow up the attenuated remnants of the latter.

Where the last white streams finally disappear the orderly arrangement, which up to this point usually characterizes the moraine-streams, may cease, and the latter, crowded directly against one another, may mingle together, becoming converted into a confused mass of elevations and depressions, with which condition of its surface the glacier-tongue moves on to its extinction. The final disappearance of white streams occurs on different glaciers at different distances from the extremity of the tongue. According to my observation, the last white stream of the Chogo Lungma was blotted out at 14·4 kilom. (9 miles), of the Hispar at 16 kilom. (10 miles), of the Kabery, first descended by our expedition in 1912, at 18 kilom. (11·25 miles), of the Biafo at about 5 kilom. (3 miles), whilst on the Siachen the central white stream persisted to within 2·4 kilom. (1·5 miles) of the end of the tongue.

A peculiar feature of the effect of lateral pressure on moraine-streams is that it often presses them up into a series of rounded or angular elevations

or hillocks covered with *débris*. These have a size varying according to the pressure and amount of ablation of exposed ice from a few to over 100 metres in height, and once produced they persist for a long time. This subject was mentioned in a paper read by myself before this Society on December 6, 1909, and printed in the *Geographical Journal*, February 10, 1910, *vide* pp. 117, 121.* To moraines exhibiting this formation I have given the name *hillock moraines*. All the above characteristics and others besides are exemplified in the moraine-streams of the Siachen, which are remarkable in size, perfection of structure, and arrangement, and constitute by no means its least interesting feature. Its trunk is banded by numerous streams of this kind, eight to ten at any point below Tarim Shehr, most of which originate in affluents, though some crop out near its centre, and one of the largest springs from the north-east wall. Among these the three largest deserve special mention.

(1) The black hillock-moraine.

This, the most prominent moraine of the glacier, is an enormous hillock-moraine covered with black slate *débris*, coming from the Tarim Shehr affluent. Gathering into its embrace detritus shed off, principally, from the northern black slate barrier, though with some additions from the centre, and transformed well up the glacier into a hillock-moraine, it finally descends along the northern edge of the Tarim Shehr as a marginal moraine, turns with this affluent into the bed of the Siachen trunk, and, crowded by the enormous pressure well over towards the centre of the latter, with the Tarim Shehr white streams between it and the north-east Siachen wall, passes down the Siachen as its largest median moraine almost to its end. Its total length is over 50 kilom. (32 miles).

At its line of first contact with the Siachen, its bulk is increased by the addition of a large, black slate-moraine and a smaller one issuing from gorges at the base of Teram Kangri. Below its junction with the Siachen, its width exceeds half a kilometre, and its hillocks, three and four abreast, reach huge proportions, rising over 100 metres (328 feet) above the depressions at their bases. I saw a number the height of which appeared to be nearly if not quite 150 metres (492 feet). Seen from the ice outside it, this moraine resembles a range of large black hills stretching down the centre of the glacier. Many of its depressions are occupied by lakes. It is the largest moraine I have met with in the Karakoram, and it does not appear likely that its equal can be found anywhere else on a valley glacier.

(2) The great limestone moraine.

Beneath some orange-coloured peaks of the north-east wall, shortly below the extremity of the King George V. ridge, where the *névé* of the north Siachen reservoir disappears in late summer, a mass of small rock-fragments presented itself to view, covering the ice for some distance from the mountain-wall. Part of this is, doubtless, brought down by the ice

* *Vide* also *op. cit.*

FIG. 5.—CAMP AT ABOUT 3800 METRES (16,300 FEET) ON GREY LIMESTONE MORAINE AT BASE OF LIMESTONE BOULDER: SIZE OF BOULDER CAN BE SOMEWHAT ESTIMATED BY COMPARISON WITH TENTS.

FIG. 6.—END OF ROCK-PROMONTORY PROJECTING INTO EDGE OF PEAK 36 GLACIER AT ALTITUDE OF 5366 METRES (17,600 FEET), WITH LAKE AND STEEP CURVING ICE-WALL FORMED BY MELTING OF ICE BY HEAT REFLECTED FROM ROCK-PROMONTORY.

FIG. 8.—LINE OF PRESSURE-SERACS SHARPENED OFF BY MELTING INTO POINTED PINNACLES (SERAC-PENITENTE) ON TARIM SHEHR GLACIER. HIGHEST, 11·5 METRES (36 FEET).

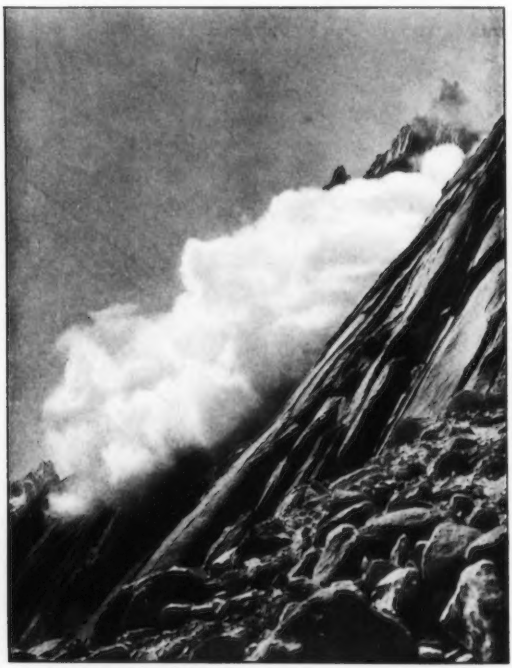


FIG. 9.—CLOUD FROM AVALANCHE FALLING IN COULOIR BETWEEN TWO GRANITE PEAKS ON BILAPHOND GLACIER. BROKEN ROCK-SURFACES HERE SEEN CHARACTERISTIC OF THE GRANITES OF THIS REGION.

from the glacier higher up, and part is derived from the wall directly above. This, as it moves down with the ice, soon takes the form of an elevated moraine, which, under the pressure of the large West Head or first western affluent entering opposite, is converted next the wall into a hillock-moraine and on its glacier-side into a raised moraine-shelf.

Receiving constant accessions of *débris* from small tributaries from the north-east wall, it gradually spreads out from the edge until it attains a width of some 400 metres (·25 mile). This moraine is composed of small fragments of limestones, marbles, and breccias of various colours, some calcite, different-coloured shales, and conglomerates. Granite, if present, is very scantily represented. I find in my notes no mention of any having been noticed in the 43 kilometres (27 miles) we followed its course. Comparatively few *débris*-masses were seen on it worthy of the name of boulders. The general colour of the moraine is grey.

Many limestone fragments contain markings in white resembling ribs with articulating heads, and vertical sections of heart shape resembling two ribs joined by a vertebra enclosing a dark centre as of some animal like a serpent or reptile. They probably represent the remains of some bivalve mollusc. They have diameters averaging 15 cm. (6 inches). They are intimately associated with the limestone and cannot be separated from it as fossils, and were only seen in transverse section. No actual fossils were found.

This moraine descends along the eastern edge of the trunk some 13 kilom. (8 miles) to the entrance of the Tarim Shehr affluent, by the pressure of which it is then deflected westward nearly to the centre of the trunk-bed and henceforth becomes a median moraine. As it turns west, its volume is increased by the accession of a moraine of considerable size, elevated 6 or more metres (20 feet) at its centre, issuing from a nala lying behind a projecting shale ridge of the north-east wall shortly above the base of Teram Kangri. This moraine consists wholly of a soft, grey limestone of a texture not sufficiently firm to merit the name of marble, mottled with black masses suggestive of fossil remains, though distinct forms are not evident. Its central ridge is crowned by a succession of immense boulders of the same limestone.

At the Tarim Shehr-Siachen junction, the main moraine meets the gigantic black hillock-moraine of the former, the two crushing out of sight a good-sized white stream caught between them, and descends side by side with it without intermingling to within a short distance of the glacier-end. Below the junction its hillocks increase in size till they rival those of the black moraine.

(3) The granite moraine.

The third large moraine first appears high up on the south side of the Peak 36 affluent, in front of the granite massif of that name, at the junction with it of a secondary affluent, as a line of discrete, oblong hillocks 4 to 8

metres high, their bases separated by ice-surfaces. As these move downward towards the Siachen trunk, they are crowded up higher by the increased pressure of other affluents till their bases unite and they form a continuous hillock-moraine, which descends as a median moraine to the Siachen, where it is amalgamated by pressure with a marginal moraine, which has descended alongside it.

Still farther reinforced by contributions from the south-west wall, it acquires a width of nearly 500 metres (1640 feet), and for the next 5 kilometres (3 miles) occupies the edge of the Siachen trunk. On meeting the Lolophond affluent descending from the Bilaphond La, its size is further augmented by junction with it of the north marginal moraine of that glacier, by which it is pushed strongly over eastward into the Siachen bed. From this point it passes far down the Siachen as a median moraine.

This moraine is composed largely of granite and crystalline *débris* mixed with shale. On its eastern edge great blocks of striped and variegated limestone were scattered about, the source of which was not evident. This was also the case with a smaller shaly moraine striking over from the centre of the glacier and joining it.

In the upper reservoirs and higher portions of trunk and affluents covered by *névé*, no signs of moraines are visible. One may walk over these for many kilometres where the virgin white expanse is unmarred by the presence of a single boulder or rock-fragment. This fact does not preclude the possibility of the existence of large quantities of rock-*débris* in the deeper portions of the ice, or the probability that the marginal portions are packed with detritus that comes to light in the moraines lower down.

As the Siachen fills its bed so completely and its enclosing walls rise from it so abruptly, there is little room for lateral moraines to be deposited, and they are only found here and there for short distances. Just above the Lolophond affluent, on west edge of glacier-bed, a huge one exists, but only for a few hundred metres.

The larger Siachen affluents join the trunk at accordant grade at angles of 90° or over with its axis in the usual manner; but the junction of the great eastern affluent, the Tarim Shehr, involves phenomena especially noteworthy. Here probably the largest existing valley tributary outside the Polar regions unites with the largest known valley glacier. The Siachen just above the junction has a width of 4·4 kilom. (2·75 miles) and completely fills its bed. The Tarim Shehr, with a width of 3·2 kilom, (2 miles) and a length of over 27 kilom. (17 miles), and falling nearly 1000 metres (3281 feet) from an altitude of 5883 metres (19,300 feet), impinges on the Siachen at an angle of 40° with its course with a shock so great that the Siachen trunk is compressed and driven over toward the opposite side, to an extent, that permits the Tarim Shehr to turn around the pointed extremity of the granite and shale Tarim Shehr promontory through an arc of 140° and take its place as a constituent part of the trunk.

The width of the glacier-bed just below the junction is again 4·4 kilom. (2·75 miles). The amount of pressure exerted by the oncoming Tarim Shehr on the Siachen may be gauged by the fact that two immense ice-bodies of unknown depth, together 7·6 kilom. (4·75 miles) wide, are crowded into a space only 4·4 kilom. (2·75 miles) wide. The plasticity of ice could not be better illustrated than by this result. The severity of the struggle incident to its accomplishment may be seen not only in the displacement of the vast Siachen ice-mass and its compression to less than three-fifths its former width, but also by the disturbance of structure in the affluent, the surface of which, as it turns around the pivotal promontory, is broken into a long line of gigantic séracs, and elsewhere rent asunder and twisted into a tortuous labyrinth of huge ridges and elevations surrounded by profound depressions, some of them occupied by large lakes. One wishing to acquire a knowledge of the difficulties and dangers of glacier-exploration could nowhere find a better opportunity than here in crossing the black hillock-moraine and pushing a couple of kilometres (1·25 miles) up the Tarim Shehr.

The periphery of the arc described by the Tarim Shehr in its change of direction is formed by its great, black hillock-moraine, that, as seen from Junction mountain above, sweeps around in a magnificent, symmetrical curve interposing a broad, black, billowy belt between the white streams on either side, from which it stands out in striking contrast. The view it presents fascinates the eye and excites the imagination, marking as it does the extent of the battleground covered in the struggle for supremacy between these two monster glaciers.

An anomalous and most interesting formation, such as in a wide experience in glacier-exploration I have nowhere else seen, occurs at Tarim Shehr promontory. About 6 kilom. (4 miles) above its extremity, a sharp shale shoulder projects like a ploughshare into the Tarim Shehr glacier. This shoulder intercepts the moraine-covered glacier-edge and part of an adjacent white stream and turns them aside over the base of the promontory as an offshoot or *true branch* some 0·53 kilom. (0·33 mile) wide, which descends towards the Siachen across the foot of Junction mountain.

As a rule, from the conditions of its existence, a glacier-trunk occupies the lowest line of drainage or flow in a valley, and ice gravitates toward and not away from it. In this case, the tremendous pressure of the great affluent forces the two ice-streams intercepted by the shoulder to overleap their natural lateral barrier and separate themselves from the main body. So great is the force exerted that the whole mass of the white stream, which impinges directly on the shoulder, is split up into séracs which, pointed off by melting, descend the declivity of the promontory as a cascade of glistening white pinnacles (sérac-penitente), forming one lateral half of the detached offshoot or branch. The other lateral half consists of the marginal moraine-stream having a smooth, dark, *débris*-covered surface.

This branch at some former period crossed the entire base of the promontory and joined the Siachen, thus making a nunatak of the promontory; but it has receded 500 to 600 metres (1640 to 1969 feet) up the slope, leaving a large amphitheatre streaked by old moraines, dotted with weathered and lichen-covered boulders, and clad with grasses, burtsa, and flowering plants, a resort of ibex of gigantic size and other animals. This is the only vegetation-clad oasis in a wilderness of ice and rock extending for scores of kilometres in every direction, and, as affording a refuge to the wanderer from the rigours of the savage expanse around, it merits the name of Tarim Shehr (Oasis-City) bestowed on it by the natives.

At various places along the course of the trunk and affluents where rock-promontories project into the glacier-bed, the glacier-edge opposite these consists of a smooth, vertical or steeply slanting wall curving around to correspond to the shape of the promontory-end, and removed from it by an interval of 20 to 40 metres (66 to 131 feet). The interval is occupied by a lake. This formation only occurs in connection with such promontories. It is caused, apparently, by the melting away of the glacier-edge by the heat radiated from the rock surfaces, and the ice melts back until a high, smooth or fluted wall is formed, and downward until a deep basin is excavated, which receives and retains the resulting water.

Such formations were found near the head of Peak 36 affluent, and of the main trunk at altitudes as high as 5365 metres (17,602 feet) and 5601 metres (18,372 feet) respectively. We were able to utilize three promontories giving rise to these for camps, in each case only after the coolies had worked two to three hours under our direction in building, with rock-fragments, retaining walls and terraces to support the tents. Although these promontories afforded but little elbow-room outside the tents, they served as most welcome situations for camps in regions otherwise deeply covered with ice and snow. Access to them was not easy. They could not be reached from the front on account of the steep, treacherous ice-walls and lakes. The only approach was by dangerous ice-slants some distance above their ends sloping sharply down to the lakes, where a mis-step would precipitate one into an icy bath, that would speedily prove fatal unless one could be immediately rescued, which might not always be possible. In one such instance, prompt assistance undoubtedly saved a coolie's life. It was not safe to approach the edges of the ice-walls at any point, as during the day they became soft, and being often undermined they broke away and slid into the lake below.

The following table shows the lengths of the five great Karakoram glacier-systems, the altitudes of the col, initial bergschrund, or highest glacier-surface, that may be considered to form their heads, altitudes of extremities of tongues, their total and average fall in metres and feet omitting fractions:—

	Length.	Head.	Tongue.	Total fall.	Average fall.
	kilom. miles.	metres. feet.	metres. feet.	metres. feet.	
Siachen	72* (45)	6400 (20,998)	3713 (12,182)	2687 (8816)	1 to 26
Chogo Lungma	48 (30)	5800 (19,029)	2896 (9,502)	2902 (9521)	1 to 16
Biafo	59 (37)	5333 (17,497)	3201 (10,502)	2132 (6995)	1 to 36
Hispar	58·5 (36·4)	5333 (17,497)	3209 (10,528)	2043 (6703)	1 to 28
Baltoro	57·6 (35·8)	5072 (16,641)	3352 (10,998)	1708 (5604)	1 to 37

From this it will be seen that the Siachen trunk lies at a considerably higher level than those of the other four systems, and that the average gradient of the Chogo Lungma is the sharpest. The gradients of all the trunks vary greatly in different portions, being steepest in the first few kilometres from their origin, comparatively slight for the greater portion of their course, and on some stretches of several kilometres practically level. It is scarcely necessary to add, that all the trunks are fed from reservoirs lying at considerably greater altitudes than those assigned to their heads.

The gradient of the Siachen trunk and of most of its largest affluents below their sources is gentle and remarkably even. Their surfaces are not disturbed by ice-falls, certainly not by such as split up the Choge Lungma in its upper third, extending across its whole width. The few ice-falls that exist are of small extent. On the contrary, crevasses in the upper parts are frequent and dangerous, being concealed by snow until late in the summer. The upper Tarim Shehr plateau, for some 8 kilom., is seamed in every direction with great crevasses and openings, which were found so dangerous that we did not feel justified in attempting to penetrate it with coolies.

The amount of ablation of the white ice through melting during a summer is great. This is made evident by the large quantity of water bathing the surface. In the upper portions, where its free movement is hindered by the presence of *névé*, it lies in great sheets, as we also found it on the Biafo and Kanibasar glaciers. Its surface freezes at night into a slushy sodden ice, that furnishes a treacherous bridging to those compelled to cross such water-areas. They were mostly negotiated by crawling on hands and knees, but this apology for ice often proving too weak to support the weight of a man even in this position, we were obliged to make *détours* to get around them.

Lower down where water can flow unhindered it courses over the surface in rivulets hurrying to escape by the lowest passages. Owing to the crowning of the white streams, the rivulets run off transversely from their centres towards the sides, ever increasing in size by coalescence with

* The length of the Siachen is somewhat difficult to define. If, as in this table, the Indira Col be taken as its head its length may be called 72 kilom. It, however, extends upward on the flank of Peak 23 some 3 or 4 kilom. farther in a great ascending snow basin.

others, till they reach the lowest line of the longitudinal angular depressions formed by the apposed edges of contiguous ice-streams. The water accumulated here from the combined rivulets forms powerful torrents which, cutting channels 2 to 10 metres (6·5 to 33 feet) wide and often over 10 metres (33 feet) deep along the lowest levels of the furrows between the ice-streams, rush seething downward to perform their mission in the scheme of glacier-evolution.

Torrents of this kind are a feature of the Siachen, and are met with in nearly all the longitudinal furrows mentioned. Some eight to twelve have to be passed in crossing the central portions of the trunk, which, as they are often impassable except where covered with *nêvé*-bridges or at points where the channel-walls approach sufficiently near each other to permit of leaping over them, offer a serious obstacle to the exploration of the glacier. One coolie lost his life and several others were injured by falling into them in 1912.

Séracs are a common feature of the steeper parts of most large glaciers, being usually associated with ice-falls. They are, in most cases, due to the splitting asunder of the ice under tension caused by the bending of a glacier over sharp increases of gradient in its bed. The resulting projecting ice-masses whitened by exposure to heat give the surface the appearance of ice-cascades.

Only a few unimportant sérac-areas due to this cause exist on the Siachen and its larger affluents. There are, however, extensive sérac-areas on the Tarim Shehr and on the Siachen trunk above and below their confluence, that are formed under entirely different and exceptional circumstances, where the glacier-bed is smooth and the gradient gentle. The cause of these is the enormous pressure developed around the junction, which forces the white ice-streams strongly upward and fractures their surfaces into large fragments or sérac-masses 10 to 30 metres (33 to 98 feet) high separated by intervals of greater or less width. These intervals which take the forms of crevasses and gullies are superficial, extending only to the bases of the séracs, the deeper portions of the glacier remaining in solid contact, thus differing from intervals between tension-séracs which usually penetrate the glacier-substance below what may be termed the sérac-bodies. Large numbers of these séracs are sharpened by melting into pointed pinnacles, constituting what I have classified as sérac-penitente, of which they form beautiful examples.

Another variety of pinnacle analogous to the last, which, from the fact that its final shape is chiefly determined by melting, may be regarded as a gigantic form of ice-penitente, is seen at places, usually at the central and lower parts of glaciers as well as also in the upper portions of low-lying glaciers, where moraine-streams greatly overbalance the white, and where the latter, having become much attenuated, are about to disappear. At these places, pinnacles 5 to 12 or more metres (16 to 39 feet) high of white ice having the form of pyramids, wedges, or crested combs, with

steep sides, and standing almost touching one another or some distance apart, project upward in lines from smooth, moraine-covered surfaces free from crevasses, their glistening, white forms contrasting strongly with the dark moraine-surfaces around them.

They appear to be developed as follows. The lateral pressure, which farther up the glacier where the white streams have greater volume only causes them to crown up in the centre, here where they have become reduced by pressure and ablation to slender filaments, crowds them up between the converging moraine-streams as high, narrow, white ridges with more or less broken summits and vertical or steeply slanting sides. Melting then causes the softer and thinner portion to disappear, leaving the more massive and resisting ones standing detached from one another as the ice-pinnacles in question. Sometimes these pinnacles are at such distance apart that relationship between them is not obvious at first sight. In other words, resisting centres being present in the elevated ice-ridges, the formation of pinnacles or gigantic ice-penitente from these occurs on exactly the same lines as that of penitente-pinnacles of any other variety. The presence at various points on the surface of the ridges of thin *débris*-deposits, which rapidly melt their way downward through the ice, accounts for a great deal of the segmentation that divides the ridges into detached pinnacles. This *débris* is usually seen covering the ice between the bases of the latter. This variety, while resembling sérac-penitente in some particulars, differs from it in that its pinnacles are not separated by crevasses, but are surrounded by smooth moraine-covered surfaces. They are also more regular in shape and rise less abruptly.

Such pinnacles were met with on the lower portion of the Sachen near the central line, and at several places on the Kabery glacier at the points of disappearance of expiring white streams. Also in great size and perfection on the low-lying Gasherbrum glacier at about 4570 metres (15,000 feet). Here they ran in two parallel lines one on each edge of a central moraine-stream. The ice-pinnacles mentioned by the various explorers of the Baltoro (the origin of which none of them has adequately accounted for, though Dr. de Filippi's suggestions accord with what I regard as the correct explanation above given), and seen in Sella's photograph opposite p. 21 of *Geographical Journal*, January 1911, and also in panorama N, on pp. 208–9–10, and opposite p. 288 of 'Karakoram and Western Himalaya,' correspond to this variety, which appears to be strikingly represented on the Baltoro.

Large areas of the glacier-surfaces were covered with the smaller varieties of nieve-penitente above the *névé*-line and with ice-penitente below it, the pinnacles succeeding one another as closely as wavelets upon water ruffled by wind and making even level surfaces difficult to move over. The most numerous and, in many respects, interesting were those of the thin *débris* or pocket variety, Var. iv. of my classification. These pinnacles of all kinds, by breaking up the surface and greatly increasing the amount

of it exposed to heat, contribute materially to ablation of the glacier. Many new features were observed regarding penitente formations, or surface projections due to melting, which will be considered in detail elsewhere.

The entrance of the Tarim Shehr affluent divides the Siachen trunk into two parts, an upper and a lower, which differ from each other in their features as essentially as might be the case with two separate glaciers. The surface of the upper portion aside from its hillock-moraines is smooth, and, except for pocket-penitente, watercourses at the lines of junction of its streams, and crevasses in the higher parts, is easy of ascent.

With the lower portion the case is different. The compression of two great ice-bodies of a combined width of 7·6 kilom. (4·7 miles) into a channel 4·4 kilom. (2·7 miles) wide must effect changes in the arrangement of their constituent parts. The evidences of pressure now become more pronounced. All ice-streams, but especially the white, are narrowed and crowded higher. The regular symmetrical crowning of the upper white streams disappears, and the ice is forced up into great ridges with high, abrupt, and, in many cases, vertical sides enclosing deep ravines through which torrents rush seething downward with hollow roar. The great white body of the Tarim Shehr is elevated considerably above the level of the rest of the trunk, and its surface converted into a labyrinth of huge séracs towering to a height of 30 to 40 metres (98 to 131 feet) separated by intricate, winding gorges.

The hillocks of the hillock-moraines, previously of modest dimensions, assume gigantic proportions and lift their heads more than 100 metres (328 feet) above their bases. The depressions between them become more profound, thus adding to their height. The lakes occupying the depressions increase also in size. Notwithstanding these changes, the individuality of the larger ice-streams is not greatly disturbed until the general breaking up into chaos occurs about 2·5 kilom. (1·5 miles) from the end of the tongue.

In view of the great moraine-hillocks with dangerous precipices, enormous séracs spiked with ice-pinnacles, ravines, glacier-torrents, high ice-ridges honeycombed with water-pockets and bristling with pocket-penitente, locomotion on this part of the trunk is neither easy nor safe, especially in crossing the glacier. Its exploration demands an outfit adapted to its conditions, an intimate knowledge of ice-craft. and fertility of resource.

IS THE EARTH DRYING UP?*

By Prof. J. W. GREGORY, D.Sc., F.R.S.

10. Central and Western Asia.

When we pass from Europe and the maritime countries of the Mediterranean into central Asia there appears much striking evidence of climatic change. It is true that Biot, in **1841**, in a memoir on the ancient temperature of China, concluded from the same plants having been cultivated in the Hoango Ho valley and silkworms having been hatched and birds having arrived and departed at the same dates as at present, that the climate of China has undergone no sensible change during the past three thousand years. In central Asia, however, there is abundant evidence of the lapse of fertile into arid lands. Lakes and inland seas have been reduced in size and number; rivers have a lesser volume of waters; once busy towns have been abandoned and their ruins smothered by sand; wide tracts of country have passed out of cultivation and been abandoned by their inhabitants; and routes crossed by ancient armies are said to be now impassable except to small caravans. There is such general agreement amongst Asiatic travellers as to the widespread distribution of these changes that Hann has felt compelled to accept the increasing scarcity of water on the highlands of central Asia as "scarcely doubtful" (**1908**, Vol. **1**, p. 352). Nevertheless there are emphatic statements to the contrary. Thus, to quote Prof. Huntington's statement of the views against his conclusion, Sven Hedin "scouts the idea of any change of climate during historic times" (Huntington, **1907**, **2**, p. 142); and he cites one school, as holding that "the climate of Persia has remained practically unaltered throughout historical time" (Huntington, **1905**, p. 308).

The distinguished Russian geographer, Berg, is most emphatic that the evidence advanced as proof of recent changes of climate in Asia should be otherwise explained, and that "the desiccation in central Asia had already come to an end in prehistoric times" (**1907**, p. 569).

The view that the climate of central Asia is growing drier was advocated forty years ago by the late Dr. W. T. Blanford on evidence from Persia, and this view has been adopted by many later travellers. He urged (**1873**, p. 500) that there has been "a gradual change in the climate of central Asia . . . from the time when the great plain north of Persia was under water," and that "to a gradual reduction in the rainfall in modern times is probably to be attributed the circumstance of the Oxus no longer reaching the Caspian, and the diminished volume of that river." Blanford's conclusion has been rejected by von Richthofen (**1877**, vol. **1**, p. 174) and E. Tietze (**1877**, p. 341), who attribute the supposed lake deposits to the action of the wind. Nevertheless it appears most probable

* Continued from page 172.

that, during the Pluvial Period of the Mediterranean and the Glacial Period of north-western Europe, Persia had a more abundant water-supply, though this was in a period too early to have directly benefited man.

Some of the most striking evidence of desiccation in Asia is from the Tarim basin, as described by Prof. Huntington (**1906**). Several rivers come from the southern mountains and disappear northward in the desert. But the dead tamarisks and jungle, which extend for 60 miles beyond the present end of the Chira river and for 20 miles north of the present end of the Keriya river, show that the rivers were recently larger and longer. He considers that "Ancient Miran, in its prime, must have required a water-supply almost scores of times as large as that now available" (Huntington, **1906**, p. 362). "The death of vegetation," he says, "is often attributed to the encroachment of sand, but in the cases under consideration that has little to do with it. Often the ground is almost free from sand. . . . The very form of the stems shows that death is not due to sand" (**1906**, p. 356).

The change in the Tarim basin he attributes to a process of desiccation affecting all central Asia. The change can be seen in Chinese Turkestan for a length of 1500 miles from east to west, and for 500 miles from north to south; while further west, the belt of country which extends for 2500 miles eastward from the Caspian has been growing less habitable for the past two thousand years. Thus he concludes "all central Asia being under the same ever-increasing stress, a succession of dry years, or a change such as has taken place in Chinese Turkestan since 1900 from an increasing to a decreasing quantity of water in the rivers, might cause migrations equal to the greatest recorded in history" (**1906**, p. 367).

Major Molesworth Sykes adopts a similar view for north-eastern Persia. In describing the desert of Lut to the south-west of Meshed, he says, "its aridity is caused by the general desiccation of Asia," and he holds that "this aridity is increasing and, except to an inappreciable extent, cannot be remedied by man" (Sykes, **1906**, p. 450).

Other cases of the spread of the desert in central Asia have been described by Dr. Sven Hedin and Sir Aurel Stein. Dr. Hedin recognizes that there has been a widespread desiccation of central Asia (**1904–7**, vol. **2**, pp. 368, 369, 309; vol. **4**, pp. 526, 597, 605, etc.), but he emphatically and repeatedly denies that there is any recognizable increase in the desiccation within historic times (**1904–7**, vol. **2**, pp. 369, 368; **4**, pp. 595–608). He tells us, for example, that he does not believe there has been any diminution in the rivers * in eastern Turkestan or in the size of the lakes in the historic period. The Lop-nor problem, he says, has nothing to do with the question, as the variations in that lake are local changes in very recent times and are no indication of any progressive climatic movement (**1904–7**, vol. **2**, pp. 307–8). Local changes happen in the distribution of the rain, as illustrated by the increase in Lake Aral

in recent years without any simultaneous rise in the Lake Kara-koschun in the Tarim basin (**1904–7**, vol. **2**, p. 368).

The changes in the nature of parts of central Asia, which have occurred during historic times, Hedin attributes to movements of sand by the wind (**1904–7**, vol. **2**, p. 369). They lead to certain areas becoming uninhabitable, although there is no increase in the total extent of the sand. "An expansion or increase of the sand in one direction is counterbalanced by a corresponding diminution in another" (*ibid.*, vol. **2**, p. 368). He therefore concludes, "the historical period is, as already mentioned, all too short, even when we appeal to the oldest extant documents, to allow of our pointing, on the strength of their authority, to any appreciable diminution of volume" (*ibid.*, vol. **2**, p. 309).*

Sir Aurel Stein accepts the view of increasing desiccation in a thorough form, for he considers that this change is also affecting most regions of the earth (**1912**, p. 257). Much of the evidence which he adduces appears inconsistent with this conclusion. He repeatedly describes cases where climatic change is inadequate to explain the restriction of cultivation (*e.g.* **1912**, vol. **1**, pp. 254, 257–8, 225, 450; vol. **2**, p. 78, 421). He attributes the changes to war, pestilence, maladministration and a feeling of insecurity, and in one case to the deposition of sand by a flood (*ibid.* vol. **2**, p. 78). He has moreover shown that this change is not universal, since he has described the reverse process to the east of Khotan, where areas of desert are being reclaimed by cultivation (**1907**, p. 33).

There is a general agreement as to the facts, but not as to the explanation of these facts. According to Prince Kropotkin, they indicate the rapid and progressive desiccation of the world throughout historical times; "a considerable body of evidence, all tending to prove that the whole of that wide region is now, and has been since the beginning of historic record, in a state of rapid desiccation. Traces of a desiccation, which has been going on with great rapidity during historical times, abound everywhere in central Asia" (Kropotkin, **1904**, p. 722). The results are, he says, that within historic times "East Turkestan and central Mongolia have not been the deserts they are now. They have had a numerous population, advanced in civilization" (**1904**, p. 733).

The most significant evidence is that of the reduction of the lakes. Thus the Caspian and Aral seas are only the remnants of a greater sea which included both of them. This sea was, however, remotely prehistoric; but from its great diminution it would appear not improbable that both seas may still be growing smaller. Kropotkin regards the reduction of these lakes as part of the general climatic change which

* Sven Hedin quotes F. Grenard, Miss. Sci. Haute-Asie, in confirmation of the view that the rivers of Khotan and the Tarim basin lost themselves in the sand, as they do now, in the epoch of the Han, and that there has been no sensible diminution in the size of the rivers during the past 1500–2000 years.

rescued the northern lands from the glacial period and dried up most of the lakes of his Lake Period. But his own statements show that the change has not been regular; as in recent years, the lakes of south-western Siberia have again increased in size, and he tells us (**1904**, p. 725) that they were then as large as in the middle of last century. The Sea of Aral has also increased, though he does not expect it will ever reach the size it did at the end of the eighteenth century. There seems, however, no adequate grounds for this expectation. The observations during Berg's expedition * shows that the Sea of Aral has risen 4 feet between 1874 and 1900. Its level has varied greatly in the past, but has apparently never been much higher than now; for Berg could find no beaches more than from 4 to 5 metres above the level of the water in 1899 to 1902 (Berg, **1907**, p. 579).

Prof. Woeikow (**1909**, pp. 84–85) adopts the conclusion that, from the thirteenth to the end of the sixteenth century, the Sea of Aral overflowed into the Caspian; and he says, "there seems then to have been a period rich in rain in eastern Europe and western Asia." In earlier times the Sea of Aral was much smaller, and it was isolated as at present from the Caspian. The fluctuations of the level of the Caspian sea are well known from the memoir on Climatic Variations by Prof. Brückner and Prof. Huntington's summary of the facts in his 'Pulse of Asia.' According to Brückner (**1890**, p. 72), the level of the Caspian has varied as follows:—

A.D. 915–921	8·8	metres	above	normal	level.	
12th century	4·2	,,	below	,,	,,	
1306–7	11·2	,,	above	,,	,,	
1638	4·9	,,	above	,,	,,	
1715–20	0·3	,,	above	,,	,,	
1730–1814			above	,,	,,	
1815	2·40	,,	above	,,	,,	
1843–6	0·59	,,	below	,,	,,	
1847	0·22	,,	above	,,	,,	
1856–60	0·27	,,	below	,,	,,	
1876–8	0·54	,,	above	,,	,,	

The level of the Caspian sea has been in constant oscillation during the past thousand years. It rises and falls in cycles which, according to Brückner, have an average length of about thirty-five years. According to Prof. Huntington (**1907**, **1**, p. 341, and **1910**, p. 666) the level of the Caspian was considerably lower in the fifth century than it is to-day; and according to Berg (**1907**, p. 571), the sea had approximately its present extent one thousand years ago.

The theory that there has been a progressive desiccation receives therefore no support from these two inland seas; and many authorities hold that the changes in the condition of central Asia are not due to

* *Geographical Journal*, vol. **18**, **1901**, p. 619.

climatic causes. For example, Colonel Waddell (**1905**, p. 299) attributes the desiccation of Tibet partly to the continued uprise of the Himalaya. The desiccation of Mesopotamia is attributed to the neglect of its once vast irrigation works. The change in central Asia, according to Sven Hedin, is due to the spread of wind-blown drift over formerly cultivated districts.

Many old historic records, in fact, indicate that the climatic conditions of various parts of Asia were similar to those of the present day. Sven Hedin has quoted Marco Polo's experience during his journey at the end of the thirteenth century from the city of Cobinan (Kuh-benan), through "a desert of surpassing aridity" (Hedin, **1910**, p. 436). It has been often claimed that the march of Alexander the Great across Beluchistan, on his return from India in 325 B.C., shows that the country has become more arid, as no army could now traverse by that route. But, as Sven Hedin has pointed out, the accounts of Alexander's march really show that the country was then a desert, occupied only by a few fish-eating savages who lived along the coast. "We have," says Hedin (**1910**, p. 436), "the same aridity, the same heat and dunes and occasional rains, the same poor population living on fish and dates and dwelling in miserable huts of the same kind and drinking from saltish wells exactly as in Alexander's time."

The desert exacted a terrible toll from Alexander's army during this march. "The army," says V. A. Smith (**1904**, p. 102), "suffered agonies from thirst, and the unfortunate followers perished by thousands." The classical accounts of this march have been collected and translated by McCrindle (**1893**, pp. 173–5, 263, 298 and 316). Arrian's account states that "the blazing heat and want of water destroyed a great part of the army, and especially the beasts of burden, which perished from the great depth of the sand, and the heat which scorched like fire, while a great many died of thirst. For they met, he says, with lofty ridges of deep sand not hard and compact, but so loose that those who stepped on it sunk down as into mud or rather into untrodden snow" (McCrindle, **1893**, p. 173). Owing to the heat, the marches were generally made by night, so the stragglers were numerous; and, says Arrian (p. 174), the majority of them perished in the sand like shipwrecked men at sea. Plutarch asserts that Alexander lost so many men on this march that he hardly brought back from India a fourth part of his military forces, though he entered it with 120,000 foot and 15,000 horse.*

Archæological evidence from the Tarim basin shows that it had an

* McCrindle, **1893**, p. 316. McCrindle, however, says the loss in men must have been exaggerated (p. 358). It has also been urged that the part of Alexander's army which, under Krateros, returned across Afghanistan along the Helmund river, could not have crossed the desert of Dasht-i-Lut to Narmashir, if that desert had been in its present condition; but if the coast of Beluchistan and south-eastern Persia were as arid then as now, it seems improbable that the country 250 miles inland should have had a greater rainfall.

arid climate even in the days of its prosperity; for, amongst other evidence, the models of the camels found by Sven Hedin in the ruins of Borasan, 3 miles west of Khotan, showed that they were the transport animals in use in A.D. 746 (Hedin, **1898**, vol. **2**, p. 765).

11. Africa (exclusive of the Mediterranean Coastlands).

The South African evidence is no more convincing than the Asiatic. Livingstone's view that the deserts are spreading has received some support. Prof. Passarge (**1904**, p. 634) regards the Kalahari as having undergone a succession of wet and dry periods before the present arid climate was well established; but A. W. Rogers, Director of the Geological Commission of Cape Colony, rejects the evidence on which Passarge relied (Rogers, **1910**, pp. 447–448), and he suggests (p. 446) that the climate of the south-western part of the Kalahari may be moister than formerly, as many of the old sand-dunes are now grassed over or covered by bush.

Passarge, moreover, regards the climate of Africa as having been constant throughout historic times; for the wetter pluvial period he refers back to the very beginning of the Pleistocene and to a date perhaps even earlier than the Glacial Period of Europe (**1904**, p. 648). He has made the very probable suggestion that many of the artesian wells in Algeria and the Libyan Sahara, and many springs in other parts of Africa, are discharging stores of old water that were accumulated during this pluvial period. His authority is therefore on the side of those who hold that there has been a geological but not an historical change of climate.

The authority of Prof. R. de C. Ward has been claimed for a climatic change in central Africa, but mainly on the headlines, for which he may not be responsible, to his 'Current Notes on Meteorology.' Amongst them are notes headed "Changes of Climate in Central Africa" (*Sci.*, vol. **19**, 1904, p. 740); "Climatic Changes in Central Africa" (*Sci.*, vol. **22**, 1905, p. 251); "A Disappearing Lake" (*Sci.*, vol. **25**, 1907, pp. 114–5). The notes themselves, however, show that Prof. Ward does not regard the desiccation as established. Thus, in reference to this way of explaining the reduction of Lake Shirwa and the reported disappearance of Lake Ngami, he says that the facts must be "more carefully studied before any definite conclusions are drawn." . . . He quotes the increase in size of Lake Rukwa and says, "Such contradictory reports show the need of great caution in jumping at conclusions of climatic change." And after the headline, "a Disappearing Lake," in reference to Lake Chad, he remarks that the lowering of the water recently reported may be followed by another period of high water; and this expectation has been justified, since the level of the lake has again increased and it is now as high as in 1904.*

In northern Nigeria, according to Dr. J. D. Falconer (**1911**, p. 214),

* *Geographical Journal*, vol. **42**, 1913, p. 297.

the present main trend of climate is towards moister conditions and the reduction of the desert. A desert period, he tells us, "immediately preceded the present more humid conditions, and is clearly recognisable in the worn and rounded dunes of the dead *erg* * of northern Hausaland. The dunes are now grassed over and covered with scattered trees."

MM. Gautier and Chudeau (**1909**) have also shown that a large part of the northern Sudan, from the Atlantic coast south of Cape Blanc, past Timbuctoo to Lake Chad, is now enjoying moister conditions, so that the old dunes are being covered with vegetation, and the desert conditions of the Sahara have receded northward (Chudeau, **1909**, pp. 244–5, 246, 254–5). Chudeau attributes the decay and abandonment of towns to the stoppage of old trade routes owing to the insecurity of the country, and says that one knows "that the climate of France and the Mediterranean has not varied at least since the Roman epoch" (Chudeau, **1909**, p. 243).

12. North America.

If the changes in central Asia are part of a world-wide movement, then corresponding changes should also be observed in North America. That there has, at some time, been a moister period in the western mountains of the United States is shown by the former greater extension of the lakes. Thus the Salt lake of Utah is now only a comparatively small lake left on the deepest part of the basin of the great Lake Bonneville, which was in existence in glacial times and had shrunk to about its present size in prehistoric times.

In North America there is ample geological evidence of changes of climate—but in times before the advent of man. Prof. Huntington maintains that there is also evidence of climatic variation during the human occupation of North America. Thus the arid regions of New Mexico have been occupied by three successive races of Indians. The first were the Hohokam, who, according to Prof. Huntington, occupied the country about 1200 B.C. They became extinct, and in the seventh century A.D. the country was occupied by the Pajoritans, who also disappeared; subsequently, in a moist period which began in the thirteenth century, the Pueblos occupied the country and held it until the eighteenth century. These successive abandonments and reoccupations Prof. Huntington attributes to climatic pulsations, of which he claims that there is direct evidence. Thus he considers that the ruins of villages and settlements in many districts, especially the Santa Cruz valley, are so numerous that the populations must have been greater—in one place, he writes, twice as great as can live there now (Huntington, **1912**, p. 275). The abundance of these ruins has, however, been explained by the rapid migrations of the people. He quotes the verdict by Mindeleff, whom he

* Dissected, desiccated alluvial country, or tracks of sand dunes.

describes as "one of the best authorities," that a band of five hundred Indians could leave the ruins of fifty villages in a century. Prof. Huntington rejects this estimate as assigning incredible mobility to agricultural people. It does not, however, seem improbable; thus in parts of Africa the agricultural tribes may be almost termed nomadic. In Angola, for example, according to the information given me by the best local authorities, the natives only cultivate the same plot of land twice running and then abandon it for many years, and though they need not shift the villages as often, they move frequently and on very slight provocation. In an arid district agricultural tribes are frequently compelled to move, for the supply of firewood is small and easily consumed, and the soil, though very productive when first watered, is quickly reduced in fertility.

As direct evidence of climatic pulsations, Prof. Huntington adduces the terraced structure of the valleys (**1912**, p. 265), which he explains as due to sheets of alluvium being deposited in dry periods and the valleys being excavated when the rain increased. Each terrace would thus indicate one climatic pulsation. But as a series of earth movements would produce exactly the same effect, the evidence of the terraces is inconclusive.

Prof. Huntington has also made ingenious use of the big trees of the western states of America. Prof. A. E. Douglass has shown (**1909**, p. 228) that the variations in thickness of the rings of growth in these big trees indicate a periodic variation in the rainfall, with periods of 11, 21·2 and 32·8 years. Prof. Huntington has extended this method * in order to determine the variations of climate during the three thousand years occupied in the growth of the giant Californian Sequoias. The interpretation of these annual rings is difficult; for the rate of growth must vary with many non-climatic factors, such as the age of the tree, over-crowding, the loss of shelter, changes in the undergrowth, epidemics of blight and insect pests, and injury by hurricane. Prof. Huntington allows for variations due to the age of the tree by a correction, but the determination of the correct factor must be difficult. Prof. Douglass has clearly shown that these trees confirm the existence of successive wet and dry periods, but the evidence hardly proves that the trees three thousand years old spent a moist youth.

These trees may indeed be quoted as evidence that the climate has not materially altered during the past three thousand years, since the conditions have remained sufficiently uniform for these forests to have continued in existence.

The claim for the desiccation of the south-western parts of the United States has been recently supported in a valuable report by Messrs. Hewett, Henderson, and Robbins on the Rio Grande valley in New Mexico, which gives a bibliography of the discussion regarding this region. Mr. Hewett, in his preliminary account of the physiography of the district, concludes

* Huntington, **1912**, pp. 401–409; Prof. Huntington's full memoir on this subject has not yet been published.

(**1913**, p. 20) that "There are evidences that the country has undergone a slow progressive desiccation, extending over a long period of time. That the epoch of human occupancy of this region extends back into the period of greater humidity seems probable." The general evidence from this district has been discussed by Messrs. Henderson and Robbins (**1913**, pp. 44–70). Their summary of the literature shows that there is a strong divergence of opinion as to the cause of the depopulation of the district. According to some authorities, it was due to desiccation from six hundred to eight hundred years ago. Other authorities, however, insist that this conclusion does not necessarily follow from the evidence. Thus a passage quoted from W. Hough (**1907**) asserts that probably "there is no geographic or climatic condition adequate to explain the depopulation of the whole region"; according to Hough, disease and occasional famine helped the process, while the most potent cause was self-extinction due to the marriage restrictions of the tribes. J. W. Fewkes (**1909**) attributes the depopulation to war, while Mindeleff, in **1891**, suggested that the population has been greatly over-estimated, owing to the same people having left many deserted settlements in the frequent removals that were necessitated by drought and changes in the water supply. Bandelier, in **1892** (*e.g.* pp. 314, 358, 464, 497, 528), enumerated many causes other than climate which may have destroyed or driven the population away. Henderson and Robbins, however, believe that there has probably been a slight progressive desiccation; it was not of any great amount, but was sufficient to render the crops uncertain; this led to wars for the possession of the better-watered tracts, and minor epidemics owing to the scarcity of food. "It seems very probable," they consider, "from the archæologic evidence that there has been progressive desiccation" (**1913**, p. 56). The district around Frijoles canyon, they consider, was most flourishing between one thousand and fifteen hundred years ago, and the ruins have been abandoned for at least eight hundred or a thousand years. They remark, however, in their final summary, that the "evidence of recent desiccation is not conclusive." The arguments, based on the present impossibility of growing corn in this district, appear doubtful; for the average rainfall at Rito de los Frijoles is estimated (**1913**, p. 44) as approximately 14 inches a year, which was long accepted in Australia as the limit of profitable corn cultivation; and the limit has been lowered. Without knowing the district it is rash to express an opinion opposed to that of the local authorities; but in view of Australian experience it would appear by no means impossible that Indians, who had become expert in the cultivation of corn in a dry climate, could have grown al that they actually raised in the Rio Grande district with an annual rainfall no greater than the present. The Indians would have had the advantages over the Australian farmers in not competing with corn grown in wetter climates, and in growing by irrigation sufficient on the floors of the canyons to support them through especially dry seasons.

The archæological evidence in favour of desiccation in this arid region during the past thousand or fifteen hundred years is admittedly inconclusive, and some geological authorities are strongly opposed to this view. Thus, according to Dr. W. C. Mendenhall, "on the whole, evidences of climatic changes in the late-Quaternary in the arid regions of the southwest have not been recognized. He thinks that as the region is one of very active and recent mountain growth phenomena which, in more stable regions, might be interpreted as indicating climatic changes are probably to be explained as due to land movement" (W. C. Mendenhall in Alden, **1910**, p. 362).

If there has been any recent desiccation of New Mexico, it would only be a local phenomenon, as other parts of North America show either no change or a reverse change. That the present climate of North America is, in many districts, even moister than formerly, and that it may be still becoming moister, is supported by many authorities. Dr. W. C. Alden (**1910**), of the United States Geological Survey, in a recent brief review of the evidence, quotes numerous authorities who believe that the climate of the central parts of the United States have had a drier climate than that of the present day. Thus the widespread deposits of loess in the upper Mississippi valley are themselves indicative of a drier period, and the fossil shells found in this loess, according to Prof. Shimek, "point to a somewhat drier climate" (Shimek, **1908**, p. 124, and in Alden, **1910**, p. 358).

Prof. C. A. Davis (in Alden, **1910**, p. 359) also infers that there has been a drier climate on the New England coast from the trees found in the peat bogs. On the eastern coasts of Canada the section in the Rockwood Bog, described by G. F. Matthew (**1910**, pp. 379–380), indicates that there has been a warmer and drier climate between two wetter and colder ones.

Warren Upham (**1895**, pp. 597–8) tells us that the lakes of Dakota "have stood continually lower than now, at least by several feet, during a long period"; and he refers to that time as a "prolonged period of comparative desiccation" which has been succeeded by the present wetter conditions. The evidence regarding the Great Plains, which extend from the Missouri to the foot of the Rocky mountains, has been surveyed by Dr. Alden, who maintains that "excepting annual variations in the amount of precipitation there are so far as known to the writer no data in hand showing that the climate over the Plains has been markedly different within recent time from that obtaining at the present" (**1910**, pp. 359–360). The now dry basins of the western mountains afford the most apparent evidence of desiccation by the disappearance or great reduction of its once extensive lakes; but, according to I. C. Russell, Lake Lahontan was completely dried up some centuries ago and since that date the climate has again become more humid (Russell, **1885**, pp. 261, 268, 273). The increased humidity has produced many small lakes in its basin.

Dr. Alden concludes that at the time of the great lakes in the western mountains of the United States, the climatic conditions did not differ greatly from those of the present, though there has been a period of greater aridity than prevails to-day. He remarks that "the change now in progress, if any, seems to be toward a more humid climate" (**1910**, p. 363).

13. Greenland.

Evidence of increased precipitation in modern times is also forthcoming from Greenland. When it was discovered by Eric the Red, in the years 980–982, the now almost uninhabited and ice-bound eastern coast was so fertile and attractive that he promptly returned with a party of colonists in a fleet of twenty-five ships. For many centuries the eastern coast of Greenland was a populous Norwegian colony.

The early descriptions are quoted in David Crantz, 'The History of Greenland,' 1767, vol. 1, pp. 243–248. He remarks that the records are often contradictory, as some authors said that the country produced the best of wheat and others that it produced little because the frost and cold nipped the seed. But even those who, like Torfæus, denied that the country would produce cereals described it as "rich in pasture, and yielding very large and fat oxen, cows, sheep and goats, that furnish a good stock of butter and cheese" (Crantz, **1767**, p. 248). Crantz remarks that he had counted nineteen bays or inlets that were inhabited on the eastern side of Greenland, and he quotes authorities who mention one hundred and ninety villages lying round them. "I rather suppose farms (*villæ prædia*, as Torfæus calls them), and these constituted twelve parishes, besides a bishop's seat and two cloysters." He also quotes from the author Theodore, that at the entrance to Einar's inlet there is "on the right a great wood, where the large and small cattle are pastured that belong to the cathedral church, which lies at the end of the bay, near the village Gardar" (Crantz **1767**, p. 246). "Further west lies Long-island, where there are eight granges or farms, which belong to the bishop's see, but the tenths pertain to the church of Hualfseyre. The next is Eirick's inlet, where the noble farm Brattahlid lies, the seat of the chief justiciary. On the west side is situated the great church on Stroemsness, which was for some time the cathedral and bishop's residence" (Crantz, **1767**, p. 246).

This part of eastern Greenland, long known as Old or Lost Greenland, is now occupied only by a few Esquimo settlements; various explanations of the disappearance of the colonists have been offered; but probably, as in other parts of Greenland, the ice has been spreading and thus rendering the country less habitable than it was before. These accounts may be exaggerated. Crantz speaks of the Icelandic descriptions as "pompous" (p. 2), but they clearly indicate that this part of eastern Greenland was far less ice-bound than it is to-day.

The old records agree with recent conclusions as to the recent enlargement in the Greenland ice and the most probable explanation of the

change is that there has been an increase of the snowfall on the Greenland ice-sheet in modern times.*

14. Local Character of Climatic Changes.

Any change in the habitability of parts of Central Asia and New Mexico that may have been established do not therefore imply any universal change in climate, for there is clear evidence of heavier precipitation in other parts of the world (Fig. 5). Increase in rainfall is less easily recognized than decrease, for the former leads to a more vigorous growth of vegetation, which usually buries or destroys the signs of any preceding arid period; whereas the conversion of a garden into a desert leaves unmistakeable evidence of the change. A world-wide reduction in rainfall is improbable so long, says Dr. H. R. Mill (**1904**), as the ratio of land and water on the earth remains the same; desiccation is only a matter of change in distribution, not in total rainfall. Changes in the distribution of rain must have happened whenever earth movements considerably changed the distribution of land or water, or the level of the land; and they must happen again.

It is quite consistent with meteorological principles for an increase of rainfall on the coastal zone of a continent to be accompanied by a decrease of rainfall in the interior; and some slowly moving influence may have led to a decrease in the water supply of central Asia and of the lands beside the eastern Mediterranean, owing to the rain which formerly fed those districts being now captured by the continental margins. Such a change may be injurious to both the areas affected, for drought may impoverish the interior of a continent, while the agriculture of the coastal districts may be hampered by cold wet summers. The old proverb, "drought never bred dearth in England," reminds us that our essential food products generally suffer from lack of sunshine and have usually more summer rain than they need; so any increase in our summer rainfall would be injurious.

15. The Pluvial Period of the Mediterranean a Result of the Glacial Period.

The problem is so complex that it is not safe to deny the possibility of even a world-wide decrease of rainfall on theoretical grounds; but there seems no adequate evidence of more than local changes of distribution in rainfall during historic times. Such local changes explain all the facts and can themselves be readily explained. The prehistoric pluvial period of the Mediterranean was probably contemporary with the Ice Age in

* According to R. W. Brook (**1910**, p. 394), Director of the Geological Survey of Canada, the snowfall is now again increasing in British Columbia. Sir H. H. Howorth ('Ice or Water,' vol. **2**, 1905, pp. 473–474) quotes evidence of a corresponding increase in severity of the Icelandic climate. Evidence has often been quoted that some Alpine passes, which are now ice-covered, were open in classical and mediæval times; thus the Alps also may have had an increase of snowfall during the past thousand years.

north-western Europe and was due to the same causes. Europe receives most of its rain from cyclonic or low pressure systems, which travel across the continent from west or south-west to east or north-east. The tracks most frequented by these cyclones are shown on Map II., which also shows that most of them avoid Greenland. When large areas in north-western Europe were covered by ice sheets like those of Greenland, the cyclones must have been pushed to the south and probably travelled somewhere along the dotted lines in the map. This change would have increased the rainfall on the Mediterranean region, and as the cyclones travelled on eastward into central Asia, moister conditions would have prevailed there also.

The Ice Age in north-western Europe was, however, long prehistoric. On the most moderate estimates, it came to an end tens of thousands of years ago, and according to higher estimates it ceased a million years ago. The climate of Europe seems to have settled down from the glacial disturbance before the beginning of historic times.

The Lake Eyre district and the adjacent regions of central Australia may have owed their once ampler rainfall to a similar variation in the cyclone tracks; for cyclones there also travel from west to east; and they would doubtless have been diverted northward when glaciers existed on some of the mountains of south-eastern Australia and covered a large part of north-western Tasmania; and the desiccation of central Australia, according to the evidence collected in 1901–2, occurred before the arrival of man, and there appears to be no evidence that it has permanently increased during modern times (Gregory, **1906**, pp. 151–154).

16. The Test of Synchronism.

Variations in the rainfall can therefore be explained by changes in the wind systems, and are due to local and not to world-wide causes. That the climatic changes which have been proved are local in range is probable from their difference in dates. The test of synchronism cannot be easily applied, for it is not fair to expect changes in different areas to coincide exactly; and as it is now claimed that the fluctuations have been comparatively slight and also very numerous, it becomes very difficult to test their coincidence.

That the thirty-five-year weather cycle, known as Brückner's period, can be recognized in many parts of the northern hemisphere, is now generally, though not universally, admitted; but this does not concern the question of any progressive change. The claims for a progressive increase are too indistinct for the test of synchronism to be of final value. The most precise test can be made by using the periods of heavier rainfall in Europe during the last century as the standard. The growth-rings in American trees and the European rainfall records, as summarized by Brückner, both agree that the periods 1831–40 and 1855–70 were dry; but they differ regarding the periods 1840–55 and 1875–85, which according to the

American trees were wetter and according to the European rain-gauges were drier than the average. These differences concern, however, the minor cycles, but the evidence as to the main variations is also not always consistent. Thus, according to Prof. Huntington, the level of the Caspian was below the average from 400 to 700 A.D., and he reports the year 600 as the culmination of a dry period in Arabia; whereas, according to the same author, the Dead sea, in 555 A.D., was at a higher level than it is now, thus indicating a moist period; and he represents Greece as having had a wet climate between about 400 and 600 A.D., during the burial of Olympia.

The question of world-wide climatic changes is not in a position, in which it can be reasonably tested by the synchronism of dry periods in different regions of the earth; for the coincidence of a wet period in a coastal district with a dry time far inland might be quite consistent with a general decrease in rainfall.

17. Local Variation of Post-Glacial Climate.

The local and irregular character of climatic changes is the most impressive lesson taught by a great compilation, on the variation of climate since the maximum of the last Ice Age, which was published in 1910 by the Eleventh International Geological Congress at Stockholm.

There is strong evidence from many districts of a comparatively warm interval since the glacial period. This evidence is especially clear in Scandinavia, where the existence of one or more warmer periods since the retreat of the glacial ice is universally admitted, though there is lively controversy as to the details of the climatic changes.

Blytt held that there has been a succession of dry and wet periods, the number of which would be reduced according to the more moderate views of Prof. Gunnar Andersson. He has shown that there was a warmer period during which the hazel spread along the Baltic coast 200 miles north of its present range; and his opponent, Prof. Sernander of Upsala, holds that in this warm period the climate became so dry that many lakes lost their outlets and many springs were dried up (Andersson, **1910**, pp. 228–235). This drought Sernander assigns to the Bronze Age, some 2500 to 500 B.C. In Denmark there is similar evidence of a warmer period between the glacial time and our own.

Similar evidence is forthcoming from Spitsbergen, Iceland (Bardarson, **1910**, pp. 350–351), Greenland (Jenson and Harder, **1910**, p. 404), the eastern coast of North America, as proved by F. H. Knowlton from the evidence of the fossil plants (**1910**, p. 369), and by Dr. O. P. Hay from the fossil mammals (**1910**, p. 374), and in Ontario, as shown by A. P. Coleman (**1910**, p. 387) from the deposits of the post-glacial lakes.

Nevertheless in other localities, as all through north-western Canada as far east as Manitoba, according to Tyrrell (**1910**, pp. 390–1), the glacial period has gradually improved to the present and the climate gradually became milder and there has been no intermediate warmer interval; the

climate passed directly into a warmer, drier continental climate without any wet period corresponding to Kropotkin's "Lake Period." According to R. G. McConnell (**1910**, p. 395) the same is true of the Yukon district in the extreme north-west of Canada.

18. Summary of Conclusions.

Owing to the varied nature of the evidence to be considered, the extensive and scattered literature whence much of that evidence has to be gleaned, and the contradictory opinions expressed by high authorities, the problem whether the Earth is drying up is hedged about with difficulties. But one fact does seem to me to result clearly from the evidence; there have been many widespread climatic changes in late geologic times, while in historic times there has been no world-wide change of climate.

If we consider particular countries, such as Egypt and Palestine, the balance of expert opinion is strongly in favour of the view that there has been no climatic change in either since the earliest existing records. The belief in a lesser rainfall in Palestine has been fostered by the oft-repeated comparison of the Hebrews between the stony wilderness of Sinai and the matured fertility of Canaan. But it may be concluded from the most precise tests now available, from the range of the date palm and the vine, and from the facts recorded by Old Testament writers, that the climate of Palestine is the same to-day as in the time of Moses.

Returning to the wider question—geological evidence shows how the passage from the climate of the Glacial Period to that of our own day has proceeded on two main lines. In some countries there has been a gradual rise in temperature since the disappearance of the ice, accompanied either by an increase or decrease in humidity. In other countries the glacial conditions were succeeded by a warm, dry period, followed again by wetter conditions. This increased humidity characterizes the present climates of Scandinavia, Germany, Hungary, Roumania, the eastern and southern parts of North America, parts of Africa from Nigeria to Cape Colony, and there is some evidence (see *e.g.* Raw, **1913**) of the same change following a dry post-glacial period in England. As an increased rainfall has been demonstrated for so many parts of the world (Map III.), it is only natural to expect a compensating decrease in other districts; and there is accordingly a predisposition to accept the claim that central Asia is suffering from increasing desiccation.

Yet it is well to remember that the extent of such change may be easily exaggerated by attributing to recent climatic changes the effects of prehistoric variations. For archæological and historical evidence shows that Central Asia and even the coasts of Persia and Beluchistan had a very arid climate in the earliest times of which we have human records, that the Caspian sea was at least as small and as low in the fifth century as it is now, and that the African and Asiatic deserts are in places again passing under cultivation. Though it must be admitted that, while

there is a strong balance of opinion in favour of the view that the aridity in Asia is being still increased, there are weighty authorities on the other side.

The explanation of the conflicting views may be that in central Asia the desert is widening in some places and contracting elsewhere. That the total rainfall in central Asia has diminished is, however, probable as an accompaniment to its increase in parts of Europe. Variations in the distribution of rainfall must result from any considerable alteration in the level of the land; the uplift of a continent must cause the rainfall to become heavier on the margins and lighter in the interior. The increase of rain on the coastlands would however hasten their lowering by denudation, and again the rain would sweep over the interior; hence that marvellous geographical equilibrium, which has rendered possible the unbroken course of evolution, would in time, unless checked by renewed uplifts of the coastlands, restore the more even distribution of the rain and revive the desolate regions in the heart of a continent.

LIST OF REFERENCES.

For further references see Huntington, **1907**, pp. xi–xiii; also Hewett, Henderson, and Robbins, **1913**, pp. 73–76; for references to the Russian literature on Central Asia, see Berg, **1907**.

ALDEN, W. C. 1910. "Certain Geological Phenomena Indicative of Climatic Conditions in North America since the Maximum of the Latest Glaciation," *Veränd. Klimas seit Eiszeit*, pp. 355–363.*

ANDERSSON, GUNNAR [Prof. of Geography]. 1910. "*Rhododendron Ponticum* Fossil in the Island of Skyros in Greece. A Contribution to the Knowledge of the Extension of a Pontic Climate in the West during Quaternary Times," *Veränd. Klimas seit Eiszeit*, pp. 145–149, 1 map.

ANKEL, O. 1877. 'Grundzüge der Landesnatur des Westjordanlandes.' Frankfurt A/M., vi. 131 pp.

ARAGO, D. F. J. 1833. "Sur l'état thermométrique du Globe Terrestre," *Ann. Bureau des Longitudes pour* 1834 (Paris), pp. 171–240.

BALL, J. 1912. 'Geography and Geology of South-Eastern Egypt.' Surv. Dept., Cairo, xii, 394 pp., 28 pls.

BANDELIER, A. F. 1892. "Final report of investigations among the Indians of the south western United States, carried on mainly in the years from 1880 to 1885." Pt. II. *Papers Arch. Inst. Amer.*, American Series, **4**, pp. 1–591.

BÁRDARSON, G. G. 1910. "Traces of Changes of Climate and Level at Húnaflói, Northern Iceland," *Verand. Klimas seit Eiszeit*, pp. 347–352.

BELOCH, J. 1886. 'Die Bevölkerung der Griechisch-Römischen Welt' (Leipzig), xvi, 520 pp.

BENZINGER, I. 1905. Article on Palestine, 'Jewish Encyclopædia,' vol. 9, pp. 479–500.

BERG, L. 1907. "Ist Zentral-Asien im Austrocknen begriffen?" *Geog. Zeit.*, vol. 13, pp. 568–579.

---

* Published in connection with Eleventh International Geological Congress, Stockholm, 1910.

BIOT, E. 1840. "Récherches sur la Température Ancienne de la Chine," *Journ. Asiatique*, Ser. 3, vol. **10**, pp. 530–570, 1 pl.

BLANCKENHORN, M. 1912. "Naturwissenschaftliche Studien am Toten Meer und im Jordantal," *Bericht über eine im Jahre* 1908 *Forschungsreise in Palästina* (Berlin), vii, 478 pp., 5 pls., geol. map.

BLANFORD, W. T. 1873. "On the Nature and Probable Origin of the Superficial Deposits in the Valleys and Deserts of Central Asia," *Quart. Journ. Geol. Soc.*, vol. **29**, pp. 493–503.

BOWMAN, I. 1909. "Man and Climatic Change in South America," *Geogr. Journ.*, vol. **33**, pp. 267–278, 602.

BROCK, R. W. 1910. "Climatic Changes in British Columbia since the Glacial Period," *Veränd. Klimas seit Eiszeit*, pp. 393–394.

BRÜCKNER, E. 1890. "Klimaschwankungen seit 1700 nebst Bemerkungen über die Klimaschwankungen der Diluvialzeit," Penck's *Geog. Abh., Wien* vol. **4**, pt. 2, pp. iv, 325.

CHOLNOKY, E. DE. 1910. "Les Variations Climatiques Post-Glaciares en Hongrie," *Verand. Klimas seit Eiszeit*, pp. 125–128.

COLEMAN, A. P. 1910. "Changes of Climate in Southern and Western Ontario since the Maximum of the last Glaciation," *Verand. Klimas seit Eiszeit*, pp. 385–387.

CONDER, C. R. 1876. "The Fertility of Ancient Palestine." Palest. Explor. Fund, Quart. Stat. for 1876, pp. 120–142.

CONWAY, SIR MARTIN. 1904. (In Discussion), *Geographical Journal*, vol. **23**, pp. 736–737.

CRANTZ, D. 1767. 'The History of Greenland: containing a Description of the Country, and Its Inhabitants: and particularly, a Relation of the Mission, carried on for above these Thirty Years by the Unitas Fratrum, at New Herrnhuth and Lichtenfels, in that Country.' Vol. **1**, lix, 405 pp., 7 pls.; vol. **2**, 498 pp., pls. viii–ix.

CURTIUS, E., and ADLER, FR. 1890–1897. 'Olympia. Die Ergebnisse der vom dem deutschen Reich veranstalteten Ausgrabung.' Vols. **1–5**, 1890 to 1897; 2 vols. of pls.; 1 vol. of maps and plans.

DOUGLASS, A. E. 1909. "Weather Cycles in the Growth of Big Trees," *Monthly Weather Review*, vol. **37**, pp. 225–237.

EGINITIS, D. 1898. "Le Climat d'Athènes," *Ann. Observatoire National d'Athènes*, vol. **1**, pp. 1–220, 391–5.

EKHOLM, N. 1901. "On the Variations of the Climate of the Geological and Historical Past and their Causes," *Quart. Journ. R. Met. Soc.*, vol. **27**, pp. 1–61.

EHRENHEIM, F. 1824. 'Om Climaternes rörlighet; Tal hållet vid Præsidii nedläggande uti Kongl. Vetenskaps Academien.' (On Variation of Climate. Discourse delivered on retiring from the Presidency of the Royal Academy of Sciences.) 12 mo. 208 pp. Stockholm.

EXNER, F. M. 1910. "Zum Klima von Palästina," *Zeit. Deut. Palästina-Ver.*, vol. **33**, pp. 107–164, pls. v-vi.

FALCONER, J. D. 1911. 'The Geology and Geography of Northern Nigeria,' xiv, 295 pp., 24 pls., 5 maps.

FEWKES, J. W. 1909. "Prehistoric ruins of the Gila valley," *Smithsonian Mis. Coll.*, **52**, pp. 403–436.

FORBES, J. D. 1862. "On the Climate of Palestine in Modern compared to Ancient Times," *Edinburgh New Phil. Journ.*, vol. **17**, New Series, pp. 169–179.

GAUTIER, E. F., and CHUDEAU, R. 1908–1909. 'Missions au Sahara,' vol. 1 by E. F. Gautier, 'Sahara Algérien,' 1908, x, 371 pp., 52 pls., 4 maps; vol. 2 by R. Chudeau, 'Sahara Soudanais,' 1909, iv, 326 pp., 38 pls., 3 maps.

GREGORY, J. W. 1906. "The Dead Heart of Australia. A Journey around Lake Eyre in the Summer of 1901–1902, with some account of the Lake Eyre Basin and the Flowing Wells of Central Australia," xvi, 371 pp., 16 pls, 6 maps.

1911. "The Geology of Cyrenaica," *Quart. Journ. Geol. Soc.*, vol. 67, pp. 572–615, pl. xlii.

HANN, J. 1908–10. 'Handbuch der Klimatologie,' vol. 1, 1908, "Allgemeine Klimalehre," 3rd edit., pp. xiv, 394; vol. 2, 'Klimatographie,' Th. 1. "Klima der Tropenzone," 1910, 3rd edit., pp. xii, 426.

HAY, O. P. 1910. "On the Changes of Climate following the Disappearance of the Wisconsin Ice Sheet," *Veränd. Klimas seit Eiszeit*, pp. 371–374.

HEDIN, SVEN. 1898. 'Through Asia,' vol. 1, xx, 664 pp., map; vol. 2, xii, 665–1278 pp., map.

1904–07. 'Scientific Results of a Journey in Central Asia,' 1899–1902.
Vol. 1. 'The Tarim River,' 1904, 523 pp., 56 pls.
Vol. 2. 'Lop.-Nor,' 1905, 717 pp., 76 pls.
Vol. 3. 'North and East Tibet,' 1905, 593 pp., 87 pls.
Vol. 4. 'Central and West Tibet,' 1907, 654 pp., 773 pls.
4to. 6 vols. and 2 vols. of maps. Stockholm.

1910. "Some Physico-Geographical Indications of Post-Pluvial Climatic Changes in Persia," *Veränd. Klimas seit Eiszeit*, pp. 431–437.

HELLMANN, G. 1908. "The Dawn of Meteorology," *Quart. Journ. R. Met. Soc.*, vol. 34, pp. 221–232, pl. iii.

HEWETT, E. L., HENDERSON, J., and ROBBINS, W. W. 1913. "The Physiography of the Rio Grande Valley, New Mexico, in Relation to Pueblo Culture," *Bur. Amer. Ethnol., Bull.* 54, 76 pp., 11 pls.

HILDERSCHEID, H. 1902. "Die Niederschlagsverhältnisse Palästinas in alter und neuer Zeit," *Zeit. Deut. Palästina-Ver.*, vol. 25, pp. 1–105, 5 pls.

HOGARTH, D. G. 1910. In discussion of "The Burial of Olympia," *Geogr. Journ.*, vol. 36, pp. 675–677, 681, 682.

HOUGH, W. 1907. "Antiquities of the Upper Gila and Salt River Valleys in Arizona and New Mexico," *Bur. Amer. Ethnol., Bull.*, 35, 96 pp., 11 pls.

HUME, W. F. 1910. "Climatic Changes in Egypt during Post-Glacial Times," *Veränd. Klimas. seit Eiszeit*, pp. 421–424.

HUNTINGTON, ELLSWORTH. 1905. "A Geologic and Physiographic Reconnaissance in Central Turkestan," "The Basin of Eastern Persia and Sistan." In 'Explorations in Turkestan with an account of the Basin of Eastern Persia and Sistan.' Public. Carnegie Instit., No. 26, pp. 157–317, pls. 4–6.

1906. "The Rivers of Chinese Turkestan and the Desiccation of Asia," *Geogr. Journ.*, vol. 28, pp. 352–367.

1907 (1). 'The Pulse of Asia. A Journey in Central Asia illustrating the Geographic Basis of History,' xxi, 415 pp.

1907 (2). "Lop-Nor—A Chinese Lake," *Bull. Amer. Geog. Soc.*, vol. 39, pp. 65–77, 137–146, map opp. p. 65.

1907 (3). "The Depression of Turfan, in Central Asia," *Geogr. Journ.*, vol. 30, pp. 254–273.

1910. "The Burial of Olympia," *Geogr. Journ.*, vol. **36**, pp. 657–675.
1911. 'Palestine and its Transformation,' pp. xvii, 443, maps.
1912. "The Fluctuating Climate of North America," *Geogr. Journ.*, vol. **40**, pp. 264–280, 392–411.

JENSEN, AD. S. and HARDER, P. 1910. "Post-Glacial Changes of Climate in Arctic Regions as revealed by Investigations on Marine Deposits," *Veränd. Klimas seit Eiszeit*, pp. 399–407.

JONES, W. H. S. 1909. 'Malaria and Greek History, to which is added the History of Greek Therapeutics and the Malaria Theory by E. T. Withington,' xi, 175 pp.

KEELING, B. F. E. 1909. "Climate Changes in Egypt," *Cairo Sci. Journ.*, vol. **3**, pp. 7–10, 86–88, 1 pl.

KNOWLTON, F. H. 1910. "The Climate of North America in Laterglacial and Subsequent Post-Glacial Time," *Veränd. Klimas seit Eiszeit*, pp. 367–369.

KORMOS, T. 1910. "Les Preuves Faunistiques des Changements de Climat de l'Époque Pleistocène et Post-Pleistocène en Hongrie," *Veränd. Klimas seit Eiszeit*, pp. 129–134.

KROPOTKIN, PETER. 1904. "The Desiccation of Eur-Asia," *Geogr. Journ.*, vol. **23**, pp. 722–734.

LAHACHE, J. 1907. "Le Desséchement de l'Afrique française est-il démontré ?" *Bull. Soc. Géogr. et d'Études Coloniales de Marseille*, vol. **31**, pp. 149–185, map.

LÓCZY, L. DE. 1910. "Sur le Climat de l'Époque Pleistocène Récente et Post-Pleistocène (Holocène) en Hongrie," *Veränd. Klimas seit Eiszeit*, pp. 119–124.

MATTHEW, G. F. 1910. "Changes of Climate in the Maritime Provinces after the Maximum of the Latest Glaciation," *Veränd. Klimas seit Eiszeit*, pp. 377–380.

MCCONNELL, R. G. 1910. "Changes in Post-Glacial Temperatures in the Yukon," *Veränd. Klimas seit Eiszeit*, p. 395.

MCCRINDLE, J. W. 1893. 'The Invasion of India by Alexander the Great as described by Arrian, Q. Curtius, Diodoros, Plutarch, and Justin,' xv, 432 pp., 2 maps.

MILL, Dr. H. R. 1904. In discussion on "Desiccation of Eurasia," *Geogr. Journ.*, vol. **23**, pp. 739–740.

MINDELEFF, V. 1891. "A study of Pueblo architecture in Tusayan and Cibola," *Eighth Ann. Rep. Bur. Ethn.*, 1886–87, Washington, pp. 13–228, pls. i.–cxi.

MORENO, F. P. 1901. "Notes on the Anthropogeography of Argentina," *Geogr. Journ.*, vol. **18**, pp. 574–589.

MURGOCI, G. 1910. "The Climate in Roumania and Vicinity in the Late-Quaternary Times," *Veränd. Klimas seit Eizeit*, pp. 153–165.

MYRES, J. L. 1910. In discussion of "The Burial of Olympia," *Geogr. Journ.*, vol. **36**, pp. 679–680.

PARTSCH, J. 1889. Review of Memoirs on Tunisia, *Pet. Mit.*, vol. **35**, Litt. ber. p. 61.

PASSARGE, S. 1904. 'Die Kalahari. Versuch einer physisch-geographischen Darstellung der Sand-felder des sudafrikanischen Beckens,' xvi, 823 pp., 21 maps and plates.

PETRIE, W. M. FLINDERS. 1894. 'A History of Egypt from the Earliest Times to the XVIth Dynasty,' xv, 262 pp.

RAW, F. 1913. 'On the Occurrence of a Wind-worn Rock Surface at

Lilleshall Hill, Salop, and of Wind-worn Stones there and elsewhere.' *Geol. Mag.*, Dec. v, vol. **11**, pp. 523–524.*

RICHTHOFEN, F. VON. 1877. 'China.' vol. **1**, xliv, 758 pp. 11 maps.

ROBINSON, E. 1841. 'Biblical Researches in Palestine, Mount Sinai, and Arabia Petraea.'
Vol. **1**, xxviii, 571 pp., 3 maps.
Vol. **2**, xvi, 697 pp., 1 map.
Vol. **3**, xi, 248 pp., 1 map.

ROGERS, A. W. 1910. "Past Climates of Cape Colony," *Veränd. Klimas seit Eiszeit*, pp. 445–448.

RUSSELL, I. C. 1885. "Geological History of Lake Lahontan. A Quaternary Lake of Northwestern Nevada," *Mon. U.S. Geol. Surv.*, vol. **11**, xiv, 288 pp., 46 pls.

SAYCE, A. H. 1895. 'Patriarchal Palestine,' 277 pp., 1 map.

SERNANDER, R. 1910. "Die Schwedischen Torfmoore als Zeugen Postglazialer Klimaschwankungen," *Veränd. Klimas seit Eiszeit*, pp. 197–246, 2 pls.

SCHIRMER, H. 1893. 'Le Sahara,' 443 pp., 6 pls.

SCHOUW, J. F. 1828. "On the supposed changes in the Meteorological Constitution of the different parts of the Earth during the Historical Period," *Edinburgh Journ. Sci.*, vol. **8**, pp. 311–326.

SHIMEK, BOHUMIL. 1908. "The loess of the Paha and River-ridge," *Proc. Iowa Acad. Sci.*, vol. **15**, pp. 117–136.

SMITH, GEORGE ADAM. 1897. 'The Historical Geography of the Holy Land especially in Relation to the History of Israel and of the Early Church,' 4th edit., xxvii, 713 pp., 6 maps.
1907. 'Jerusalem: The Topography, Economics and History from the Earliest Times to A.D. 70,' vol. **1**, xxi, 498 pp., 6 maps, 10 pls.

SMITH, V. A. 1904. 'The Early History of India from 600 B.C. to the Muhammadan Conquest, including the Invasion of Alexander the Great,' x, 389 pp., 6 maps and plans.

SMITH, W. 1863. 'A Dictionary of the Bible comprising its Antiquities, Biography, Geography, and Natural History,' vol. **2**, vi, 1008 pp.

STANLEY, A. P. 1856. 'Sinai and Palestine in connection with their History,' lvi, 533 pp., 7 maps.

STEIN, M. AUREL. 1907. "Expedition in Central Asia," *Geogr. Journ.*, vol. **29**, pp. 31–35.
1912. 'Ruins of Desert Cathay, Personal Narrative of Explorations in Central Asia and Westernmost China.'
Vol. **1**, pp. xxxviii, 546, 6 pls. and map.
Vol. **2**, pp. xxi, 517, 10 pls., 2 maps.

SYKES, P. MOLESWORTH. 1906. "A Fifth Journey in Persia," *Geogr. Journ.*, vol. **28**, pp. 425–453, 560–587.

THIRLMERE, R. 1905. 'Letters from Catalonia and other parts of Spain,' 2 vols., pp. ix, 810, map and fig.

TIETZE, E. 1877. "Zur Theorie der Entstehung der Salzsteppen und der angeblichen Entstehung der Salzlager aus Salzsteppen," *Jahrb. k.k. Geol. Reichs*, vol. **27**, pp. 341–375.

---

* Mr. Raw has given me a supplementary statement as to the post-glacial age of this æolian action.

TREITZ, P. 1910. "Les Sols et les Changements du Climat," *Veränd. Klimas seit Eiszeit*, pp. 135–137.

TYRRELL, J. B. 1910. "Changes of Climate in North-Western Canada since the Glacial Period," *Veränd. Klimas seit Eiszeit*, pp. 389–391.

UPHAM, W. 1895. "The Glacial Lake Agassiz," *Mon. U.S. Geol. Surv.*, vol. **25**, xxiv, 658 pp., 38 pls.

WADDELL, Col. L. A. 1905. 'Lhasa and its Mysteries,' xxii, 530 pp., maps and plates.

WARD, R. DE C. 1904–07. "Current Notes on Meteorology," *Sci.*, vol. **29**, 1904, p. 740; vol. **22**, 1905, p. 251; vol. **25**, 1907, pp. 114–115.

WATT, A. 1903. "The Climate of Hebron in Syria," *Journ. Scott. Meteorol. Soc.*, Ser. 3, vol. **12**, pp. 133–152.

WOEIKOW, A. 1909. "Der Aralsee und sein Gebiet nach den neuesten Forschungen," *Pet. Mitt.*, vol. **55**, pp. 82–86.

ZUMOFFEN, R. P., S.J. 1899. "La météorologie de la Palestine et de la Syrie," *Bull. Soc. Géogr. Paris*, Ser. 7, vol. **20**, pp. 244–364, 462–488.

The PRESIDENT (before the paper): Dr. Gregory, the distinguished Professor of Geography at the University of Glasgow, is well known to geographical audiences. He has appeared before us on more than one occasion in recent years, although it is now nearly twenty years since he first described to this Society the results of his explorations of Mount Kenia in British East Africa, for which I may add, in passing, he received one of the Society's awards. Not long after that he brought before the Society, partly at one of our meetings and in ampler detail in the *Journal*, some valuable observations on the physical geography of British East Africa. Later on he was with Sir Martin Conway in Spitsbergen. Fourteen years ago he discussed at one of our meetings the plan of the Earth and its causes. More recently, he has given two papers—one on the geographical factors that control the development of Australia, the other on the scientific results of Antarctic expeditions. These are a few among the many contributions which this eminent geologist has made to geographical science. You may judge, therefore, that no one could be better equipped than he to deal with the important subject which he is to bring before us this evening.

Dr. W. N. SHAW: I have listened with pleasure to Prof. Gregory's interesting discourse, all the more so because what he has said has been on a subject which, though very closely allied to that which is entrusted to me in the Meteorological Office, is not entirely identical therewith. We are proud to be able to present to those who care to come and look at it, a diagram illustrating the rainfall of every month in the neighbourhood of London, for the one hundred years from 1813 to 1912. Even that, though it goes about fifty years beyond the period during which we have ourselves made regular observations, is a very small fraction of the period which is covered by the researches that Prof. Gregory has put before us. With most of what Prof. Gregory has said, in such an eloquent and able manner, of the conclusions which he draws from the evidence he has put forward, I am in agreement.

The only doubt that rises in my mind is whether or not Prof. Gregory's argument has not been too conclusive. In approaching a subject of this kind, when we are dealing with the changes that may or may not take place, I like to look at it, not from the direct point of view as to what evidence there is of change, but from the point of view of what one would have to suppose done in order to prevent changes being made. In all the phenomena that are characteristic

of the world's history, changes take place; and it is most interesting to think out what would have to happen if no changes were taking place. Prof. Gregory has shown that the changes of climate that have been claimed are almost negligible. With regard to this question of the desiccation of the Earth, the variation of rainfall on the Earth or of its distribution, there are a great many things that would have to be assumed if the state of the water supply were to be kept identical from age to age. In the first place, as Prof. Gregory suggested, you would have, of course, to keep the sun unchanged. Then, again, you have to keep the distribution of land and water as at present; and, again, you have to keep the composition of the atmosphere in its present condition, because any variation in the amount of carbonic acid, for example, in the atmosphere would almost certainly produce a change in the rainfall. So also would any change in the salinity of the sea or of the mean temperature of the Earth or in the distribution of ice. Of these we know that the distribution of land and water is certainly changing, and consequently we must assume that the distribution of rainfall is also certainly changing, and the problem is how we can measure the change which must certainly take place in consequence of the gradual alteration in the distribution of land and water. If you go back to geological times there must have been great changes in the climate, and whether we are now taking part in them or not is an interesting subject to discuss. On one point I should like to express my special agreement with the opinions expressed in Prof. Gregory's paper, and that is in connection with the great influence of sand. There are two agencies against which, if they are sufficiently prolonged, the human race is powerless, and those are sand and snow. Sand is the worst in the long run, because it is constantly being formed and it does not melt even when the weather is warm. Take my criterion of what you would have to do in order to keep the economic conditions the same, and apply it in the case of an inland area, such as one of the lake valleys of Central Asia, where there is a lake without an outflow. You have got to add to the conditions I have already mentioned some method of scavenging, in order to clear away the sand. How many people would have to be employed to clear away the annual accumulation of sand from one of the lake-valleys in Central Asia? Without regular scavenging the disappearance of the lake is only a matter of time though the rainfall be what it has been. I can quite understand denizens in Central Asia, after murmuring with the Walrus and the Carpenter, "If this were only cleared away. They said it would be grand," deciding to remove to a quarter where the constant encroachments of sand were less extensive. Sand is a matter of great importance in considering those questions of the inland districts. It is not so much, of course, the case for the fringes of the sea-coast, because there it may be washed away.

This interesting paper recalls to my mind a matter which occurred when I was giving evidence before a Committee with a view to the re-establishment of the Science Museum, now proceeding under Captain Lyons' direction, in South Kensington. What I value most about the paper is not so much the opinions —those may be erroneous—but the magnificent collection of evidence, and what I should like to see is some means by which the evidences of climate in any age, first in historic times, then in prehistoric times and geological times, could be collected and put together in one place and duly represented on some form of diagram or map without necessarily including the opinions based upon the evidence for the time being. I wanted the Museum to have a large apartment, and divide it into pigeon-holes, each representing a longer internal of time as we go further and further back, and the vision becomes more and more telescopic; and put into the pigeon-holes all the evidence as it comes forward for

the study of the climate in different parts of the world in successive ages, going backwards and backwards. I am afraid that at the time I spoilt the chance for the moment by the indiscreet mention of the word "palæometeorology"; geologists are a little suspicious of any one else becoming possessed of anything with "palæo" at the beginning of it. But I trust I may use this occasion of the collection of most interesting materials once more to urge as strongly as I can the putting together of the evidence for the changes of climate in present and past ages, and keeping it ready for exhibition in a form suitable for a great museum.

Dr. H. N. Dickson: I have listened with very great satisfaction to Prof. Gregory's paper, inasmuch as it supports the views that I have myself long held, chiefly perhaps from a fear of the consequences of holding any views to the contrary. I have had a dread of any such subject as Dr. Shaw would call palæogeography, for it has always seemed to me that geography had quite enough to do to attempt a description of the surface of the Earth as it is, without trying to consider what the surface of the Earth might have been at some previous time: it has in effect been my desire to leave the study of the Earth as it was in geologic times to geologists. I have been interested, while listening to Prof. Gregory, in observing again the extraordinary difficulty of dealing with evidence of this kind. There are a number of points which I think have still not emerged. We have evidence of desiccation based very largely upon depopulation—that is to say, areas occupied at one time and now no longer occupied, but it does not follow that because a region was occupied in a time of stress, it would continue to be occupied when more genial regions became available, even although the region in question had not suffered any change of climate. That, I think, is a point which requires bearing in mind constantly in matters of this sort. I think students of colonial history will agree that the success and progress of a colony is not to be determined solely by the favourable or unfavourable geographical conditions that are found in the area under colonization. Then there is another point. If this secular change of climate takes place, evidence of its occurrence must be found in regions which were not simply on the edge of aridity. There would be evidences of changes of modes of life and occupation, and in vegetation, which would support that found in the extreme case of complete aridity. I know of no evidence of that kind. All this, I think, goes to show that the question of the habitability or non-habitability of a region gives but a very meagre indication of any variation in its climate. One does not need to go further than another source of information which Prof. Gregory did not refer to, namely, some inquiries which have been made from time to time in connection with the supply of water available for London. The amount of information and evidence which appears to show that since the time of the Roman occupation the amount of underground water available in the neighbourhood of London has been steadily diminishing, is quite extraordinary. I take great comfort from Prof. Gregory's results in the confirmed belief that whatever changes have taken place in climate during historic times have been exceedingly small. I think that even from the geologic point of view it is clear they cannot have been very great; because after all the range of temperature between 32° and 212°, the "water" stage, covers practically the whole of the geological period. Also, although the period of civilization is long, and the period of scientific investigation short, the evidence of the thermometer and rain-gauge is of so much greater precision than the evidence of the kind usually brought forward that I cannot think that these changes would have taken place in consequence of variations of climate without having been at least suggested

by some of the more precise instruments of observation that have now been in use from between one hundred and two hundred years.

Sir THOMAS HOLDICH: While I have listened with very great interest to Dr. Gregory's lecture, I have been exceedingly comforted by his conclusions that, after all, the world is in no particular danger of drying up; and that the relation which Nature has ever maintained between moisture and solid matter is likely to be maintained in future. At the same time, according to my small experiences, the evidence of desiccation, particularly in the matter of the drying up of lakes, is absolutely too forcible to be overlooked. Some twenty years ago, when we were settling the boundary between Russia and Afghanistan, we set up a pillar at the eastern end of Lake Victoria. Some recent travellers in that direction have informed me that the lake has receded so far from the pillar now that it is nothing more than a large pond surrounded by swamp. Sir Hamilton Bower told me not long ago that he has evidence that those lakes which he came across on the Tibetan plateau on his first great trek across Tibet from west to east, are drying up so fast that in many of them where he found an abundance of water-fowl, there is hardly any water left, and the fowl no longer visit them. There is yet another country with which I am well acquainted where the evidence of desiccation is very forcible and apparently quite recent. I refer to the country of Baluchistan—that part of it extending between India and the Persian gulf—the part of Baluchistan to which Prof. Gregory referred when he said it was the country through which Alexander retreated from India. It is called Makran. In the main it is a dry country now; it is a mountainous country—there is no part of it that you can really call desert in the ordinary acceptation of the term, and there are beautiful valleys, full of vegetation, full of cultivation, green ribbons of wealth running right through it, where water is abundant, where palms grow, where the dates are reckoned the finest in the world. There are evidences in Southern Makran of huge constructions, probably built by a race of Arabs—whom I have always believed to be the Himyaritic Arabs because they were the greatest builders in the world—huge dams constructed of stones of enormous size, for the purpose of storing water where water no longer exists. The ruins of these extraordinary constructions are spread pretty nearly through the length and breadth of Makran, but particularly on the southern coast. There are also evidences of desiccation, which are so recent as to be surprising—evidence of old terrace lands which were formerly under cultivation, which seem almost as if they were abandoned yesterday; and there is at least in one place a forest of desiccated trees, very similar to those which you saw in the photographs of Turkestan taken by Sir Aurel Stein. All this points, to my mind, to quite recent desiccation. I do not believe myself that the force which Alexander led through that country perished of thirst because there was no water in it. I believe that there was a considerable supply of water then, and that the desiccation has set in since his time. The reason why he brought his force to such grief was not that there was no water, but that he took the wrong road. He was anxious, all through, to support his fleet of Indus-built boats which were making their way along the coast, by means of his force on shore. Consequently he hugged the coast as close as he could, and after leaving the Hingol river, where Nearkos encountered those aboriginal people, of whom Sven Hedin says there are representatives to-day, but who have disappeared long ago, he followed a mountain track which would have puzzled any general even in these days. Although he was only within that track for a comparatively short period, it was quite enough to destroy his force. You know how very soon a force can be demoralized by want of water: I have seen a whole brigade broken up in the

course of an hour or two—I have known men actually die of thirst on a long march before water could be taken from either end to save them. After observing these evidences of desiccation which are so strong, and, to my mind, so recent and rapid in the northern hemisphere, it interested me very much to see what might be taking place in the southern hemisphere. When I was right away down south in the lake region of Patagonia, I was very much interested to observe that in all the great lakes there was a probable diminution from year to year. Even in the course of a year or two I observed that the lake called Argentina, which is a glacier fed lake, had receded considerably; not only had the volume of water diminished greatly, but a very large area of good pasture land had come into being, on which cattle were being grazed. That was the result of only about two years' observation. But you must remember that in the extreme south of South America there are operations going on, for which we cannot account, in the form of unheaval and depression of the land to which there is no parallel so far as I know in any other part of the world. On the Chilean side, coasting along by sea, you may actually pass over the tops of a submerged forest and be able to see the trees beneath your boat. Not very far from that point, a little to the northward (some 100 miles or so), you may find sea-shells uplifted 200 feet on the shore cliffs. The extraordinary earth-movements still going on there were likened by my friend, Dr. Moreno, to a gigantic concertina played by the hand of Nature.

If it is thus in the northern and southern hemispheres, what about the equatorial regions? There, again, we know that the lakes are disappearing almost as rapidly as anywhere else. Lake Tanganyika has subsided some 20 feet within the course of the last ten years or so; but here in the equatorial regions there does appear to be certain compensation. From the coast opposite to British Honduras, stretching away westward through northern Guatemala to Southern Mexico, there is now one vast forest, and this vast forest covers ruins of extraordinary size and intense interest belonging to the past civilisation of the Maya people, which must have existed all through that country; indicating undoubtedly that there must have been in times past—a time which I do not put so very far back—vast areas of land under cultivation to support so large a population as these ruins suggest, and that the forest has gradually taken its place owing to the increased rainfall. The forest must have followed the moisture certainly. Those of us who have ever travelled in Ceylon will possibly have observed, particularly at Anuradapura, which is the Holy of Holies of Buddhism, the extreme rapidity with which the jungle can actually rend to pieces old edifices originally of great strength and size, and the rapidity also with which nature covers up all evidences of the former existence of buildings of any sort. From that, and from what I have observed in Central America as to the extent to which the forest has demolished these buildings, that they cannot be of any very ancient date, I should say that probably they are not more than about 1500 years old. It is satisfactory, in this part of the world at any rate, to note that there has been a change from a dry period to a moist period, probably within historic times. And so I am glad to think that on the whole the balance of nature is preserved. I am convinced that it will take years and years yet of careful observation and careful record to establish any facts which will really prove, either one way or the other, that the world is drying up or that it is getting moister.

The PRESIDENT: You will agree with me, I am sure, that we have had a paper of unusual scientific value and learned research, followed by a discussion of no small interest. The discussion has taken this shape. The gentlemen of science have stood together with the unity characteristic of their profession, and have

presented an impenetrable front, upon which, however, a certain impression was endeavoured to be made by the traveller Sir Thomas Holdich. I am sorry that we had not more travellers to speak to us to-night, particularly from Central Asia, because I can truthfully say that, of the men who have distinguished themselves by explorations in those regions, the greater number are strong believers in the increasing desiccation theory. If Mr. Carruthers—our Gold Medallist of a year ago, and the author of an admirable book on Unknown Mongolia—had been here he would have had something to say from the point of view of his own experiences in Central Asia. Sir Francis Younghusband would have said much the same thing; and in the days when I used to travel in those countries I encountered in many cases evidence, supported by historical facts, of desiccation on a large and increasing scale. Therefore, while offering all due deference to the scientific phalanx that I before described, I think there may be something to be said on the other side which has not been said this evening. However, one great debt we owe to the reader of the paper: he has accumulated and placed before us an enormous amount of evidence, which, so far as I know, cannot be found anywhere else; and it may be that although the men of science, led by him, have had their way to-night, some of the authorities on the other side may come up in the *Journal* later on and discuss the views that have been laid down. For the moment it only rests with us to express our hearty thanks to Prof. Gregory for the information that he has given.

THE IMPERIAL TRANS-ANTARCTIC EXPEDITION.*

By Sir ERNEST H. SHACKLETON, C.V.O.

Prof. David has outlined very clearly the main scientific—and especially the geological problems—that remain to be solved in the Antarctic. It is not my intention to deal with these various points, nor am I capable, not being a trained geologist, of discussing them from what I might call an inside point of view, but it is obvious to every layman that an immense amount of work remains to be done in the South Polar regions before the knowledge of this mysterious country is complete.

In my written statement to this Society (*Geographical Journal*, February, 1914, p. 173), I said that first and foremost the main object of the expedition is the crossing of the South Polar continent from sea to sea. Some people condemn this object as spectacular and of no particular use, and consider that no expedition should set forth without the one object of being purely scientific. Until the South Pole had been reached, deep in the mind of every explorer who penetrated into the Antarctic was the desire to reach this goal. Every expedition that set forth equipped to penetrate into the Antarctic, from the leader downwards,

* Statement made by Sir Ernest Shackleton at a meeting of the Society on February 9, 1914, after the paper on Antarctic Problems, by Prof. Edgeworth David, which will be published in a later number.

had the desire to get as far south as possible. My desire is to cross the Antarctic continent, and in undertaking this expedition the members of it are the agents of the British nation. If I said differently I would be untrue to my convictions. I have put the crossing of the continent as the great object of this expedition, and there is not one person in this room to-night, and there is not one individual who is under the Union Jack in any part of the Empire, who does not wish the British flag to be the first national flag ever carried across the frozen waste. But though this is the foremost aim of the expedition, it does not mean that science is not to play a part almost as great in the expedition. I am thoroughly alive to the demands of science; I am fully alive to the need of scientific work; I am aware that this gathering here to-night came to hear a scientific discussion. Now, how are the demands of science to be satisfied by the work of this expedition? I will give you briefly the personnel representing science on the expedition.

The trans-continental party will consist of six men, and one of those six will be a trained glaciologist and geologist, and as the main work of the trans-continental party, apart from the journey, will be the study of ice formation and the nature of the mountains we may expect to find, this will represent science.

The other five members of the expedition will devote their attention when the long day's march is over, and in the intermediate intervals that constitute breakfast and lunch, and on the march itself, take note of the meteorological conditions, and one especially will daily take the magnetic dip readings.

The very nature of the journey from sea to sea will solve, once and for all, the question of a divided continent or a homogeneous continent. Therefore every step taken into the unknown, apart from the sentimental reasons, is an advance to geographical science. Should we do the last 800 miles over known country in order to ensure our certain return, there are 900 miles of new country to satisfy the most exacting critics. Better to go the last 800 miles over a known route and bring home your results and your knowledge, than not to come back at all, for then there would be no results to science, for, the party being dead, there would be no information. So much for the trans-continental journey.

At Weddell sea base there will be eight other men, making three parties. One party of three will move from winter quarters towards Graham Land to the west, and this will be one of the most important of the journeys. This party also will have a trained geologist. They, I hope, will be able to make close examination if they come across mountains—which they should do—and find whether Graham Land mountains link up with the mountains that we found west of the Pole and traced further to the south-east by Amundsen.

The eastern party will proceed towards Enderby Land to the east, and will also have a geologist and glaciologist, and two men will remain at

the base station of the Weddell sea, one a biologist to deal with the biological problems that present themselves as regards the sea fauna and land fauna, and another, a meteorologist, will be a trained meteorologist, and will, with the aid of self-recording instruments, study continuously the meteorological conditions of the Weddell sea, which, in conjunction with the South Orkney station of the Argentine Government, help to throw light on the rainfall of South America, to show the importance of meteorological observations in the Antarctic. It has already been found that there is a close relation between the rainfall of Chili and South America generally with the open or close season of the Weddell sea. This, by the way, has already an economic result and will have, when further known, a more far-reaching effect on the agricultural industries of this great country.

The Weddell sea ship will do hydrographical work under the complete charge of Captain Davis, who has had a great deal of experience in trawling, dredging and sounding in the Antarctic ocean, and I am glad to say that Sir John Murray has agreed to take charge of all the samples we recover from the bottom of the ocean, and he stands pre-eminent as regards this work, as is well known. Also on board the ship there will be a biologist. So much for the Weddell sea scientific party.

On the Ross sea side, a depôt party of six, who may proceed south of the point that I shall definitely select later, will have in their complement one trained geologist. It may be that I shall decide to go down the Beardmore glacier, which we discovered during the *Nimrod* expedition, and this party may proceed to the top of the Beardmore glacier and camp, if time permits, for three weeks, whilst waiting for the trans-continental party just about the position of Mount Buckley where we discovered for the first time seams of coal in the Antarctic. This area is a veritable paradise for the geologist, and here he may read at first hand the story of the rocks and all that has been before and that has passed in the remote geographical periods before this land was hidden beneath the ice. I think it is only fitting that this area, which we had the good fortune to discover and to bring back specimens from, should be further explored by an expedition consisting of largely the same members.

Therefore, to sum up from the scientific point of view, I hope to have on the expedition, four geologists, two biologists, one meteorologist, all of such calibre and knowledge as will ensure a certainty of good work, and I would add that the laymen of the expedition will be no whit less enthusiastic and desirous of helping the experts in the acquirement of this scientific information.

As I said at first, and I want it to be the last thing in your memory, I do not hide the fact which I have already stated openly that the crossing of the continent lies first and foremost in our hopes, and I feel that whatever it may be called, sporting feat, or whatever name it may go by

amongst the sympathetic or the unsympathetic, this work is the primary work of the expedition.

If there is anybody in this hall to-night or in the large audience that will read this to-morrow, who is ready to put up ten, twenty, thirty, or forty thousand pounds to aid the scientific side of the expedition I will take as many geologists as they are ready to provide me with. It has always been the case with Polar expeditions of making bricks without straw, and it really ought not to be any part of the work of the leader of an expedition to have the anxiety of collecting funds; his energy should be entirely devoted, and the energies of his comrades, to the organization of the expedition.

REVIEWS.

EUROPE.

The Yorkshire Moors.

'The Moorlands of North-Eastern Yorkshire: their Natural History and Origin.' By Frank Elgee, F.G.S. London: A. Brown & Sons, Ltd., 1912. Pp. xvi., 361. 70 *Illustrations* and 2 *Maps*. *Price* 15*s. net.*

In this book the author has gathered together the results of over fifteen years' research into the biology and geology of the moorlands of north-eastern Yorkshire. Moors in different parts of the British Islands have been described by Robert Smith, W. G. Smith, C. E. Moss, W. M. Rankin, F. J. Lewis, R. Ll. Praeger, and G. H. Pethybridge, and the results summarized in A. G. Tansley's 'Types of British Vegetation.' On the continent of Europe valuable work on moors has been published, especially by Schröber, Weber, and Graebner. Mr. Elgee has duly taken this work into account in the valuable contribution which he makes to the subject.

The first nine chapters deal with the botanical aspects of the moorlands, the next four with the geology, and the three following with the zoology (chiefly birds and insects); and there is a well-written concluding chapter in which the results of the author are summarized. An appendix gives valuable particulars relating to the moorland butterflies and moths of Europe; and there is a very good index. The work is illustrated by about seventy photographs, reproduced in half-tone, and there is a fully coloured geological map of the district, and a map indicating the extent and boundaries of the moors. The book is written in an interesting way; and, although it can scarcely be described as a popular work, its technicalities are not so pronounced as to render the study of the book difficult to non-scientific readers.

Many controversial points are discussed, and naturally, therefore, the conclusions stated by the author will not be accepted by all specialists; but it is right to add that the author makes it clear whenever he is dealing with disputed matters, and that his opinions are stated with due modesty, though with perfect frankness and without ambiguity. It may be pointed out that the author differs with Mr. Clement Reid on the important subject of the influence of the glacial period on the flora of this country, for Mr. Elgee believes that the driftless portion of his area supported some kind of vegetation throughout the period of

glaciation, and that this vegetation included not only genuine Arctic species, but also many of the chief members of the present flora, such as heather (*Calluna*), cotton grasses (*Eriophorum*, spp.), crowberry (*Empetrum*), and mat grass (*Nardus*). The author's idea of "Arctic" species is perhaps wider than that of most plant geographers; and it may be doubted if he has sufficiently considered the possibility that the driftless area of this northern locality might have been a more or less permanent snow-field during the Glacial period.

The "moorlands" of north-eastern Yorkshire are described as "heaths" in Tansley's 'Types of British Vegetation'; and consequently some discussion on the relationships of moors and heaths might well have been included within the scope of the book.

References to allied literature are freely given in the form of footnotes; but it would have been of great assistance to students if these had been summarized at the end of the book.

There can be no doubt that Mr. Elgee has produced both an interesting and valuable work on biological geography, and that his book represents an important addition to the extensive literature of a great county. C. E. M.

Anglo-Saxon England.

'The Archæology of the Anglo-Saxon Settlements.' By E. T. Leeds. Oxford: Clarendon Press. Pp. 144. *5s. net.*

Mr. Leeds, assistant-keeper at the Ashmolean Museum in Oxford, is well known to *Fachmänner* as a competent and vigorous student of Anglo-Saxon archæology. In the present monograph he discusses the archæological evidence which bears on the course and chronology of the English conquest down to about 600 A.D. Like other recent inquirers, he throws overboard the traditions of the A.S. Chronicle, on which the older modern narratives (for example, that of J. R. Green) depend. What he would substitute is not yet quite clear; he is, of course, like the rest of us, at the beginning of a difficult research, and many of his conclusions, as he frankly admits, are still uncertain. But his volume contains some new suggestions which are likely to stand; it advances knowledge, and deserves the attention of scholars. Perhaps it would gain that attention more easily if its author had aimed at a more lucid style, a terser and directer exposition, and a clearer grouping of arguments; perhaps, too, he would have done wisely to have aided his readers by more illustrations. But his stuff, rough-hewn though it be, is real. Of geography, with which we are here mainly concerned, he says little—indeed, too little. He notes, interestingly enough, the dislike of early English settlers in East Anglia and elsewhere for clay soils (pp. 44, 55, 69), but he gives no illustrative map. He emphasizes the preferences of the same settlers for river-valleys and their avoidance of Roman roads (p. 18), but his map is too small and far too sparsely named to help the reader, and he himself whittles his own conclusion down by pointing out that it is not true north of Lincoln (p. 71), nor in Kent (p. 100), and we suspect that he might have added another exception, along the Peddar Way in East Anglia. He should correct, too, his sweeping statement that along the Roman road from Bourn to the Humber there is not a single village with an English name, either on the road itself or within half a mile (p. 17); there are quite half a dozen. A mysterious sentence on p. 18 about two roads "near East Stoke and Burton" also seems to need revision of some kind. On the whole, we doubt whether Mr. Leeds, despite various interesting and valuable reflections, has got to the bottom of Anglo-Saxon geography. Perhaps he would reply that no one else has, and that it is not here his proper business.

'Coast Erosion and Protection.' By E. R. Mathews. (London: Griffin & Co. 1913. Pp. xiv., 147; 33 *Plates*. 10*s*. 6*d*. *net*.) The author is an experienced engineer who has constructed numerous sea-walls and coast defence works. He has dealt in this book with the evidence before the Royal Commission on Coast Erosion. There are numerous illustrations showing great waves which have damaged sea-walls. The book is generally accurate, but the author repeats the old fallacy that the materials of the Yorkshire coast have been carried south by the tides and deposited on the Lincolnshire shore, and that they are also being carried up the Humber. A reference to the proceedings of the British Association at Glasgow in 1901 will show that this is impossible. There is no indication that alluvial matter is being carried into the Humber on a flood tide.

'L'Archipel de la Manche.' By Camille Vallaux. (Hachette. Pp. 245. *Illustrations*. 4 *fr*.) The author has spent several years in the Channel islands and has produced an interesting guide-book which deserves wide use by visitors. There are many well-chosen illustrations which show the picturesque character of the sea cliffs. A translation of a short passage describing Sark may give some idea of the contents: "The north-east coast of the island consists of lofty walls of mica-schist and gneiss in alternate horizontal layers of different colours. Only a narrow strip of beach is uncovered at low tide, and this can only be reached from the top of the cliff at one place by means of a steep goat track."

'Hellas and the Balkan Wars.' By D. J. Cassavetti. (London: Fisher Unwin. 1914. Pp. xv., 368. *Maps and Illustrations*. 10*s*. 6*d*.) The objects of this volume are principally to set in a proper light the Greek character and the share and conduct of Greece in the recent war. The author claims Greek origin, but his views are in no way, on that account, favourable towards the Greeks in any exaggerated sense. He summarizes the causes of the war, and then deals analytically with the sea and the land campaigns, a process which involves much matter of topographical interest and value. The book is for the rest mainly political, as the maps (which are clear and good) are also. Chapters on Athens and Greek women during the war, and on the "spirit of Hellenism," are added by a pseudonymous hand, and Mr. W. Pember Reeves supplies an introduction.

'Camping in Crete.' By A. Trevor-Battye. (London: Witherby. 1913. Pp. xxi., 308. *Map and Illustrations*. 10*s*. 6*d*.) This book is of considerably higher scientific value than its title might suggest: its character is in great part narrative, but its main object is to give an impression of "the appearance and 'feel' of the island"; it succeeds, and fills a gap in Cretan literature by doing so. There is a long appendix of "Notes and Observations," including sections on the caves of Crete (a subject identified with the work of Miss Dorothea Bate), fauna, flora, people, industries, harbours, etc., which make the book a source of reference on the modern island of quite encyclopædic character. A good map with brown relief-shading, on a scale of 1 : 600,000, is not the least useful feature of the volume: it shows the wide range of the visitor's travels in the island. Numerous photographs of fair standard effectively illustrate the text.

ASIA.

'China Revolutionized.' By J. S. Thompson. (London: T. Werner Laurie. 1913. Pp. 590. *Map and Illustrations*. 12*s*. 6*d*. *net*.) A review of the events that have attended the Chinese revolution during the past two years. The author, who hails from the land of the Stars and Stripes, has devoted much

time and attention during his sojourn in the country to a study of Chinese institutions from every point of view. Little enough is told us about the geography of the interior, as the author has directed his observations principally to the treaty ports and more civilized centres. On the whole the volume supplies a comprehensive picture of the Celestial Empire, and may be said to be thoroughly up to date, which is saying a good deal for its utility, considering the far-reaching changes of the past few years.

AFRICA.

Archæological Survey of Nubia.

'The Archæological Survey of Nubia. Report for 1908-9.' By C. M. Firth. Cairo: Government Press. 1912. 2 vols., large 4to. *Plates and Maps.* £E2.

The work of the archæological survey of the portion of the Nile valley which will be inundated by the raising of the Aswan dam has been noticed in the *Journal* (July, 1911, pp. 68–9). The river-level will be affected for some 100 miles up to Korosko, permanently covering many remains of antiquity along the banks. It is important, therefore, to put these on record whilst still accessible, and this is being done in a thorough and elaborate manner by the survey, of which the reports of the first two seasons have now been issued. These cover the river from Shellal to the neighbourhood of Dakka, and deal mainly with cemeteries; the temples, except those on the island of Philæ, being above the threatened level. The examination of thousands of graves, extending from the pre-dynastic times of Egypt to Christian and Moslem times, throws considerable light on the history and ethnology of the region, confirming the southward movement of culture up the Nile valley. On the hills behind the temple of Kalabsha, Mr. Firth believes, the graves of the dreaded Blemmyes of Roman times have been found, and his argument appears very plausible. The larger monuments, for the reason given, do not come in for consideration; but a mud-brick fortress at Ikkur, near Dakka, partly Egyptian Old Empire (3rd dynasty?) and partly Middle Empire (12th to 17th dynasties), is described, with plans and views. The admirable series of plates illustrating the interments, and the finds of pottery, inscriptions (translations of these should have been added), implements, scarabs, beads, etc., add much to our knowledge of the peoples of the Nile valley. A series of maps on the ample scale of 1: 25,000 accompanies the report, and there are detail plans on larger scales.

It would be well if Egyptologists could come to an agreement as to local nomenclature. In this Report we find such varied spellings as "Taifa" and "Teifa," "Naga ed Deir" and "Naga ed Der." The cemeteries investigated are indicated by numbers instead of by local names; it would be much more convenient if they were named after the nearest village or other topographical feature. And there can be no further need to continue Dr. Reisner's "C group" and "X group," when these are now generally recognized to represent the Middle Kingdom and Byzantine-Pagan periods respectively.

F. A. Edwards.

The Thonga Tribe.

'The Life of a South African Tribe.' By Henri A. Junod, of the Swiss Romande Mission. Vol. 1, "The Social Life" (1912). Vol. 2, "The Psychic Life" (1913). Neuchatel: Imprimerie Attinger Frères; London: Macmillan & Co., Ltd. 15*s. net each volume.*

The Thonga (pronounced T-Honga) are a Bantu tribe inhabiting that part of South-East Africa which lies between St. Lucia bay and the Sabie river.

North of the Limpopo they do not, as a rule, occupy the coast-line. Westward the tribe extends beyond the Portuguese boundary into the northern Transvaal. Six main groups or clans are distinguished among them. The best known is the Ronga group in the Lourenço Marques district. The Thonga number about 750,000 souls; some 82,000 are found in the Transvaal, chiefly in the Zoutpansberg division. They have little idea of national unity, and no one name which they themselves recognize. The name "Thonga" (people of the East) is that given to them by the Zulu, and by the whites they are often called Shangaan. The Thonga—who should not be confounded with the Tonga living in the Inhambane region—have, however, characteristics which mark them out as a separate unit of the great Bantu stock.

It is this tribe of which the Rev. H. A. Junod records the life-history. Their origin is obscure, but there is evidence pointing to the probability that some of the clans occupied their present lands as far back as the fifteenth century.

M. Junod briefly indicates the country occupied by each clan, and a coloured map showing the distribution of the groups is also printed. It is, as the author says, of the greatest importance that all facts should be classed geographically, and in doing so in this work he has laid students of ethnography under a great obligation. His detailed account of the life of the tribe is drawn mainly from his intimate knowledge of the Ronga group. It is the result of fifteen years' close study by a man whose mental equipment for the task is conspicuous, and who has already, by his writings on the Ba-Ronga, gained an honourable record as one who combines the true scientific spirit with that of a missionary of the Cross. In volume one, after the geographical introduction, M. Junod describes with a wealth of detail the life of the individual from birth to death; first that of a man and then that of a woman. This is followed by the life of the family and of the village, and then again by a description of the national life. Volume two, the psychic life, is divided into the following parts: the agricultural and industrial life, the literary and artistic life, and the religious life and superstitions. In short, every aspect under which the Thonga can be studied is here presented to us. The section on cosmographic and meteorological phenomena may be instanced as of special interest to geographers.

This full presentment of the life of a single tribe is worth many books of generalization; at the same time no one can read this account of the Thonga without gaining some insight into the lives of all the Bantu tribes of South-Eastern Africa. M. Junod has adhered loyally to his aim of noting facts accurately and recording them impartially. But his position as a missionary leads him to add observations on the future of the Bantu, and the best methods of evolving from his existing beliefs and customs a higher civilization—the lines on which the natives should be directed "to escape shame and destruction." These observations are printed in separate sections and in different type, so as not to interfere with the scientific presentment of the Thonga as they are. No part of the book deserves, however, closer study. M. Junod is aware of the defects of native converts; he admits that "mission Kaffirs" are not in very good repute, but his conclusion, based on knowledge and long experience, is that the only salvation for the South African tribe is Christianity (accompanied by education). Anthropogeography will be an even more interesting study than it is if such salvation be wrought. The future civilized and Christianized South African will be able to learn in such works as this of M. Junod from what he has been evolved.

F. R. C.

Upper Senegal and Niger.

'Haut-Sénégal-Niger (Soudan Français).' Deuxième Série. Géographie Économique par Jacques Meniaud. Préface de M. E. Roume, ancien Gouv.-Gen. de l'A.O.F. 2 vols. Paris: Emile Larose. 1912. 12 *Maps and* 192 *Illustrations*. 20 *frs. the two volumes.*

Mons. Jacques Meniaud's book is the second of a series of studies of Haut-Sénégal-Niger published by direction of Mons. Clozel, governor of the colony. One's first reflection is that similar works on British crown colonies ought to be forthcoming, but are not. They certainly do this kind of thing much better in France.

The exposition of the economic geography of the French Sudan, as it used to be called, here given us, deserves to be characterized as masterly. The author excludes from his survey, save in the most general manner, the country lying east of the Niger. It was an annex to, rather than an integral part of, the colony of which he treats, and has now been separated from it. "L'Est-Nigérien," as the author calls this semi-Saharan district, is commercially outside the orbit of the rest of French West Africa, being practically a dependency of British Nigeria. To facilitate its trade a continuation of the railway from Kano to Zinder is advocated.

Though of great extent, the upper Senegal and middle Niger countries form "an economic entity," and the author begins with a summary description of the land and people as a unity. He next discusses means of communication, treating in detail of the Senegal, the Niger (and its navigable affluents), road routes, and railways. As becomes the study of a country all *hinterland*, particular attention is paid to the routes giving access to the outer world, at present for practical purposes two only, the one *viâ* the Senegal, the other *viâ* the Konakri-Niger railway. It is noteworthy that the author thinks the trans-Sudan and trans-Nigerian railway schemes can wait, but that the Ivory Coast and Dahome lines should be continued with all speed, and in such directions as to preserve for France the trade of the lands of the Niger bend, whose natural tendency is to seek an outlet through the Gold Coast or through Togo.

Then in the order named come dissertations on the fauna, the sylvan products, the agricultural and the pastoral resources of the colony, and on its industries and commerce. Nothing seems omitted; in the section on horse-breeding there is even a discussion of the merits of the "American mount" for jockeys. Indeed, Mons. Meniaud is very human throughout. Whenever we are taken to a new district, its salient features are lightly sketched, its natives introduced, and their homes described before technical details are entered upon. A geographical groundwork is, with the author, the basis of all knowledge. The numerous maps given help naturally to an appreciation of the points put before us.

The future of the country is bound up with agriculture and stock-raising, here perfectly distinct occupations: the cattle and sheep-owning tribes—Fula, Tuculeurs, Tuareg, etc.—are nomadic, and grow no crops; the farmers own no cattle, or, if they do, they pay some Fula herdsmen to look after them away from the farm. Population is sparse (there are few regions in Africa where it is otherwise), and this wasteful method is possible. The farmers are slow in the uptake, and, save in the collection of rubber, they have made no advance in methods since the advent of the French. But they cultivate larger areas, and commerce has increased fourfold in ten years. Rubber, ivory, ground-nuts, gum, skins, ostrich feathers, wool—these constitute the chief exports. Two of the most

valuable animals, the Masina wool-bearing sheep and the horse, are introductions from Asia. They thrive; another alien, American cotton, does not. There is, however, an assured future for the indigenous cotton-plant. The industries are of little importance, and the absence of coal will tend to keep back certain enterprises. Though gold is abundant, it is not being worked on a large scale, nor is it likely to be for years to come.

An immense development of agriculture is foreshadowed in schemes to regulate the flood-waters of the middle Niger. In the "central delta" of the river, as the author calls the region of lakes and waterways above Timbuktu, an area equal to one-sixth of the cultivable land of Egypt could, at comparatively little cost, be placed under irrigation. What the Nile has done for Egypt, the Niger may, some day, do for this country. Much larger irrigation works are possible, but they are not at present required. The study of the *régime* of the Niger is particularly interesting; it includes that of its lower waters.

The very numerous and excellent photographs illustrate all aspects of the country, its peoples, and products.

F. R. C.

The Red Sea Coast.

'Desert and Water Gardens of the Red Sea.' By Cyril Crossland. Cambridge: University Press. 1913. *Sketch-maps and Illustrations. Price* 10s. 6*d*.

Mr. Cyril Crossland is marine biologist to the Sudan Government, and has for some years been in charge of their pearl-shell fisheries. In connection with these he has travelled up and down the coast, visiting the reefs. His head station is at Dongonab, a bay about 100 miles north of Port Sudan. Here he leads an isolated existence in charge of numerous pearling vessels and a village of sailors —a father to his people, but himself absolutely divorced from social intercourse with his own race. In vivid chapters he tells us of his people, their daily life, their social conditions, their religious observances and superstitions, their work, and their marital affairs. There is a simplicity in it all. The facts are facts culled by a keen observer, one who knows of what he writes and never writes to make a book. Dongonab is a poor, barren place, indeed, but its people are typical of many a Red sea settlement. They will charm the reader as through weary years they have beguiled the author. The photographs of them at work and play are a credit to both author and publisher.

The coastal plain is a desert, but it has an ever-changing beauty of its own in sunshine and storm, in that wonderful clear air through which the light and shade on the precipices and rugged peaks of its mountain backing, 80 miles away, are clearly visible. Yet a single rainstorm brings out what to the resident seems an amazing wealth of life. It is really meagre, a striking contrast to the gardens of the sea. coral beds fringing the shores, and a barrier of reefs broken by innumerable channels of vivid blue. Few waters have such an extravagance of life, algæ, many with skeletons of dense lime, coral, zoophytes, and innumerable wandering beasts of every lowly kind. The attached forms are builders of reefs, and the piling up of their remains, which results in these, is lightly sketched. Many shore reefs owe their whole breadth to this upbuilding, but others have been broadened by the eating of the waves into the older elevated limestones which fringe the coasts.

The author is tempted for a few pages to go into the vexed question of the formation of different kinds of reefs, and his last chapter is a serious contribution to that question and to that of the making of the Red sea He regards the latter as a rift, and he traces three successive series of barrier reefs, two of which

have subsequently by elevation been added to the land. To the reviewer these elevated barriers seem scarcely comparable to the existing barrier system, which has some parts with remarkably deep water (over 100 fathoms) between them and the mainland. There is not enough evidence of the supposed faulting, especially of the faulting which is presumed to have formed harbours and other fissures in the coast.

Yet, while different authorities will disagree with different points, all will find abundant food for thought. Best of all, we are able heartily to congratulate the author on demonstrating by his simple language and illustrations how a vexed scientific question may be made clear even to the most unscientific reader.

J. Stanley Gardiner.

The Tripoli Enterprise.

'Italy in North Africa.' By W. K. McClure. London: Constable & Co. 1913. 10*s.* 6*d. net.*

The conquest of Tripoli by Italy is an event that must ever loom large in the history of the Mediterranean, especially with the added interest of its forming a resumption rather than an annexation of territory, as indicated by the wealth of Roman remains still to be seen in the country. Mr. McClure's judiciously compiled volume is sure to arouse general interest in a region whose past history shows it, in the opinion of some, to be one of the great possibilities. Near Ajilat the ruins of Sabratha include an amphitheatre that held ten thousand spectators, and at Lebda the remains of Leptis Magna recall the memory of Septimus Severus, who, though born so near the southern rim of the known world, ended his life at York, nearly 2000 miles to the north, but still within the limits of the empire he had ruled. In Roman times the Tripolitan coast strip and the Cyrenaican plateau must have been veritable gardens, and the remains of aqueducts, reservoirs, statuary, Roman coins and pottery, mosaic pavements, and vaulted tombs bear eloquent witness to a civilization which, though the task will be arduous, may well flourish anew.

The author's sojourn in Tripoli covered some four or five months in 1911–12, during which period he wrote for the *Times*, and rendered careful service in personally investigating operations and localities figuring prominently in the course of the expedition. The first chapter, "A Retrospect," is also useful, for, although mainly political, it supplies a temperately written review of the great international events and developments, from 1838 when Mazzini claimed northern Africa for an Italy that was not yet in being, to the Italian declaration of war in September, 1911. While the bulk of the work partakes of the narrative character, the concluding chapters, viz. "The Italian Army at work," "Italian, Arab, and Turk," "The Future of the new Colonies," and "Italy and the Powers," cast valuable light on side issues which must be of importance for the future of the country. The numerous photographs are varied and interesting and clearly printed, while the three large maps are reproduced from maps compiled by the military authorities in Tripolitania during the war.

'Winning a Primitive People.' By Donald Fraser. (London: Seeley, Service. 1914. Pp. 320. *Map and Illustrations.* 5*s.*) This book deals with missionary work among the Ngoni tribe and the Senga and Tumbuka peoples of Central Africa. It is a valuable volume of its type, the author possessing a profound acquaintance with the manners and customs of the natives with whom he has come in contact, and placing on record here very full accounts of them, not only in regard to their attitude towards Christian teaching, but also in their untaught condition. A map (as to which it may be observed that it is unsafe

to draw meridians freehand) shows the sphere of the writer's labours to lie in Nyasaland; his experience extends over sixteen years, and it must be felt that, apart altogether from his missionary work, he has made full use of them.

'Some Austral-African Notes and Anecdotes.' By Major A. J. N. Tremearne. (London: Bale, Sons and Danielsson. 1913. Pp. xii., 215. *Illustrations.* 7*s.* 6*d.*) The author rings up his curtain on a scene of South Africa in war-time, but the bulk of the volume is concerned with incidents and experiences in British West African territories. The subjects of the various chapters are treated for the most part in light vein—they make excellent reading, and though hardly to be commented upon from any geographical standpoint, it may be permitted to refer with especial gratitude to the delightful chapters on Coast English and the Native Correspondent, and on West African journalism.

AMERICA.

The First American Voyages.

'Die erste Entdeckung Amerikas im Jahre 1000 n. Chr.' Von Dr. Gustav Neckel. R. Voigtländers Verlag in Leipzig, N.D. Pp. 92. *Price* 80 *Pf.*

The author gives the story of the Norse voyages in extracts from the Icelandic chronicles, as Reeves did so fully for English readers ('The Finding of Wineland the Good:' 1895). He agrees with Prof. Storm that the Helluland, Markland, and Vinland of Karlsefni (A.D. 1003) were Labrador, Newfoundland, and Nova Scotia respectively, but doubts whether the Vinland of Karlsefni was identical with Leif's (A.D. 1000), which may have been situated near Boston or even farther south. He therefore rejects as untrustworthy the statement of the Flatey book, that Karlsefni and his companions found and inhabited the huts erected by Leif. Yet it does not seem improbable that they may have been guided to the spot by information obtained from the former expedition, nor impossible that one of Leif's men may have accompanied Karlsefni. There is no reliable and definite record of subsequent visits to Vinland, but a ship is spoken of as having come from Markland; and there is no mention of Norse settlements in America. All that can be affirmed with any confidence, is that Norsemen made voyages to the coasts of America, and that the physical features and vegetation, as described by them, agree with those of the countries above mentioned. So much, at least, may be reasonably accepted. Mr. Babcock (*ante*, p. 194) objects that grapes do not ripen north of Massachusetts, but Cartier found them on the St. Lawrence.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Fiords as Rift-valleys.

'The Nature and Origin of Fiords.' By J. W. Gregory, F.R.S., D.Sc. London: John Murray. 1913. pp. xvi., 542. *Diagrams and Illustrations, Bibliography, and Indices. Price* 16*s. net.*

Prof. Gregory has often previously shown his power of thinking easily in terms of oceans and continents; and he does it well in this work, transmuting his personal knowledge of the African Rift-valley and many other regions into a world-splitting hypothesis, with the cracks still open. He claims that all real fiords, wherever found, are rifts or fault-fissures, somewhat modified by later agencies but originated by great earth-movements late in Tertiary times; and he brings together a mixed multitude of authorities and of observations to support his case.

How that "bonny fighter," G. H. Kinahan, the last but one of the old champions of "fissure-valleys," would have relished this book, had he lived just a little

longer! And how he would have scoffed at the moderation of its author! His 'Valleys and their relation to Fissures, Fractures and Faults,' referred to with mild approbation by Prof. Gregory, was published in 1875; either too late or too early; for it fell on days when the views that it advocated had been abandoned, and when the adequacy of rivers to excavate the biggest and deepest valleys of the Earth had been convincingly established. More recently Sir H. H. Howorth couched a lance in the same forlorn cause, in 'Ice or Water' (1905, vol. 1, chap. ix.), but without much avail. Of late years, however, there have been indications from various quarters of a returning swing of the erosion-pendulum, so that physiographers will not be altogether unprepared for Prof. Gregory's pronouncement. Nevertheless, the first impression of most will be that this is a set-back, not of the pendulum but of the clock. Revived with such weighty argument, the "fissure-hypothesis" for the special case of the fiords is likely to receive careful reconsideration and rediscussion alike from geographers and geologists; yet, that the present work will suffice to re-establish it even for this case is, at least, doubtful.

Prof. Gregory's main thesis is concisely stated in his preface: "All the fiord-systems of the world have the same essential characteristics. Fiords occur in trough-shaped valleys that are arranged along fractured lines or networks; their plan resembles that of cracks in a fractured sheet of brittle material, and does not agree with that of systems of valleys cut by rivers or glaciers. Fiords are restricted to plateaus which are composed of firm and usually old rocks and to districts which are on the borders of sunken areas. All the fiord-areas have been affected by a similar succession of earth-movements; they were uplifted into plateaus after the great crustal disturbances which upheaved the existing mountain-systems of the world. During these uplifts the areas composed of hard rocks were cleft by radial or intersecting cracks, and the subsidence of belts of country along these cracks, or the removal by wind, water, and ice of the decayed material along the clefts, produced the great fiord-valleys. After the plateau-forming uplift, the fiord-areas have undergone a series of oscillations, during which many of the valleys have been drowned by the entrance of the sea, while the unequal movements and tilting of the region have formed deep basins in many of the fiord-valleys.

"The fact that most of the fiords are in the colder regions of the earth is a coincidence, due to the polar areas having been affected by greater oscillations than the equatorial zone. The mountainous coasts beside the warmer seas are indented by fiords in the occasional areas, where the edges of foundered regions have undergone a succession of movements similar to those around the heaving polar are..." (p. vi).

It may be said at once that there is hardly a point in which these opinions cannot be legitimately challenged, even when the author's skilfully massed evidence has been duly weighed. But the task of the challenger will be formidable, from the immense range of the subject, if for no other reason; and we can here only just skirmish on the fringe of the controversy. Before venturing even so far let us briefly recapitulate the contents of the volume.

After the summarizing preface from which we have already quoted, the book contains, in the first part, a statement of the supposed problem as to the origin of fiords, a classification and nomenclature of the coast types of the Earth, and a discussion and definition of fiords and allied coastal features. Then, in the second part, there is presented a systematic description of the fiord-systems of the world in detail, with a passing review of the literature of the subject in each region; and, in the third part, the author develops his conclusions and

controverts antagonistic views. A long bibliography adds to the usefulness of the book, and a few scenic plates, with numerous maps and diagrams in the text, serve well to illustrate the subject-matter.

While pressing his main thesis steadily forward, Prof. Gregory manages to bring into prominence several side-issues of geographical consequence; among them, the vexed question of glacial erosion and hanging valleys; the nomenclature of processes of denudation; the æsthetic effect of land-shapes, and its influence upon human character; and the deformation of the Earth under contraction. The broad range and confident grasp of the author on all these matters, together with the easy style of his exposition, will commend his book to many readers beyond those interested in the main discussion.

To the average field-geologist with the "parochial or provincial" outlook deprecated by the author in his preface (p. vii), it will seem most probable that Prof. Gregory, like Kinahan and Howorth before him, has cast the net of his hypothesis too widely, gathering in valleys of as varied quality as the poets who have yielded the quotations at the headings of his chapters. And it is upon the result of local criticism in detail that the hypothesis will ultimately stand or fall. Every experienced geologist is aware that valleys frequently coincide with fault-lines, and that the stretches where there is this coincidence are often exceptionally deep and straight. Indeed, when a valley suddenly takes a deep straight course across hard rocks, one regards the fact as presumptive evidence for the presence of a fault; and, in the same way, when a fault-line is found to strike across the "grain" of the land, as is so commonly the case, one looks instinctively for its sign in a more or less recognizable depression or notch on the ridges between the valleys. But it can usually be proved beyond question that all such features are the secondary results of faulting, from the bringing of hard and soft rocks locally into juxtaposition, or from the weakening of resistance by local crushing or the development of "shatter-belts" (a term, by the way, that the author, on p. 457, wrongly assigns to Peach and Horne, instead of to its originator, Dr. J. E. Marr). We find, in short, that the fault-line has been etched out by differential erosion, but only in those places where the favourable conditions have been produced, and to the degree proportionate to these conditions; where such are wanting, the fault promptly loses its surface-expression, and masks its trail under the general outlines of the land. Prof. Gregory is, of course, well aware of these secondary fault-features, and he specifically rules them out of the category of his "tectonic" valleys (p. 394); but there can be little doubt that some—perhaps many—of his selected fiord-company are of this type.

Most field geologists, again, will find it hard to grasp Prof. Gregory's conception of faults produced on a catastrophic scale as gaping fissures. Indeed, it is not quite clear how far the author himself carries the idea. He allows that the hypothetical late-Tertiary fissures that are supposed to have given origin to the fiords were enlarged by running water in pre-Glacial times, and by ice during the Glacial period, but he does not explicitly define his views as to their first state. In his general argument, however, it seems to be assumed that the fault-fissures gaped open with sufficient rapidity to entrap the older drainage in ready-made new valleys. This is not the kind of faulting with which geologists are familiar. Our evidence indicates that most faults have been produced gradually; sometimes, perhaps, by slow continuous displacement; but more often by successive short slips (causing earthquakes), with long intervals of quiescence. In many cases it is demonstrable that the surface features produced by individual slips were so slight as to have been soon overpowered and obliterated by the normal processes of erosion. Only in a few desert regions have the insignificant scarps

of recent faults been observed; and one can recall no case in which a scarp of this kind is known to have permanently overmastered a pre-existing drainage system.

Further, in view of the rate at which land-surfaces of high relief in every part of the world are re-shaped by the agencies of erosion, most geologists and physiographers will hesitate to entertain the suggestion of a world-wide fissure-system so recent that the scars still persist. Right or wrong, the hypothesis runs counter to the uniformitarian grain of prevalent ideas, and must be closely scrutinized before it is accepted. The old explanation that the fiord-areas are deeply trenched because they are high lands bordering the sea, therefore peculiarly favourable for sharp erosion by rivers or glaciers or both, has a broad simplicity that still commends it.

On the much-debated question as to the excavatory energy of glaciers, Prof. Gregory holds an intermediate position, granting that the old ice-streams have been to some degrees effective in planing and modifying the fiord-valleys, but denying that they have been a principal factor in the production of the trenches. It is singular that in the long dispute on this subject there has been so little said about the conditions on the rim of the great Antarctic plateau bordering the Ross barrier. In this region we know that enormous confluent glaciers discharge through straight deep trenches from the upland snow-fields, and it seems improbable that any other conditions have ruled during the existence of the plateau at its present elevation. So far as the reviewer is aware, it is not supposed that the valleys have ever been empty of ice, or that there has been any opportunity for running water to aid materially in their excavation. And if this be the case, then it must be granted that here, at any rate, the ice-streams have proved that they are fully capable of valley-excavation on an extensive scale.

G. W. L.

Hydrology.

'Rainfall Reservoirs and Water Supply.' By Sir Alexander R. Binnie. London: Constable & Co. 1913. *Illustrations.* 8*s.* 6*d. net.*

We might describe the book before us as beginning with hydrography and as ending very definitely in hydrology; for while the earlier chapters deal with such matters as rainfall, drainage systems, catchment areas, floods and evaporation, the later ones go on to such highly technical subjects as reservoir and aqueduct construction, water storage and supply to houses, in which water is studied in its mechanical properties and not as an element in the processes of physical geography. As all land waters have their ultimate origin in rain, the book naturally commences with a somewhat elaborate discussion on the more practical aspects of rainfall study, such as mean annual fall, fluctuations from year to year, and the difficult question of the relation of "run off" to amount of rain. The rainfall statistics given refer to this country or India, where the author has had professional experience in applying a knowledge of rainfall conditions to the procuring of water supplies. In view of the abundant rainfall figures quoted in connection with the great storage reservoirs, natural and artificial, in the north of England, it is not a little remarkable that there is not a single reference to the work of the British Rainfall Organization, whose director, Dr. H. R. Mill, is so constantly consulted by engineers like Sir Alexander Binnie, in a professional capacity. There is, it is true, some allusion to the statistical methods of the founder of the organization, the late Mr. G. J. Symons.

We would do well, in the connection of rainfall, to correct two errors in Sir

Alexander's book which may also be found in most textbooks of geography whose authors have not any very special knowledge of meteorological principles. On p. 5 we are told that "the hills on the western shores of England, Scotland, and Ireland first condense and precipitate the moisture contained in the south-west winds blowing from the Atlantic, which, becoming nearly exhausted before they reach the eastern side of our island, are unable to give out the same copious rainfall." The major error from the geographical point of view contained in this statement lies in supposing that the highlands of Britain, where the rainfall is always excessive, are high enough to cast rain shadows on their lee side after the manner of the great mountain chains of the Earth. So little do the Pennine and Cambrian ranges exhaust the moisture of the south-westerly winds that the rainfall of the east of England is but little short of what it would be if these highlands did not exist, and if a high range traversed East Anglia in a north-and-south direction it would provoke there a similar high rainfall. The minor error consists in regarding the hills as condensers—assumably by contact action. This may be partially true in winter, but in midsummer the heated hill-slopes would often have a reverse—a drying—effect on the cool winds from the Atlantic. It is mainly by a thermodynamic process that the hills send down the rain: they force the winds, which they obstruct, upwards into higher levels where the sudden expansion, consequent upon reduced atmospheric pressure, involves cooling of the air and condensation of its aqueous vapour.

The information given upon the influence of geological factors on springs and rivers, and on the quality of water to be used for economic purposes, is full of interest; and quite apart from the special importance of Sir Alexander Binnie's wide experience to civil and sanitary engineers who will use it, the book is well worth being read by geographers if only as an aid to the proper understanding of hydrographic problems. In civilized countries the circulation of waters is greatly complicated by the artificial control to which they are all more or less subjected, and its study not only opens out many interesting subjects of inquiry, but frequently brings home many facts one would otherwise perhaps never realize.

L. C. W. B.

Relief in Maps.

'Contours and Maps explained and illustrated.' By Frederick Morrow. London: Meiklejohn & Son. 1913. *Price* 1*s.* 6*d. net.*

The aim of the author is to give a thorough grasp of the principles underlying contours, and the methods to be adopted in drawing them. The exercises which are set at the end of each chapter will doubtless be found useful by the busy schoolmaster; but we doubt if the book itself is well adapted for use by his scholars.

The author seems to be burdened with the necessity of saying fair things of the so-called "oroscopic" method of showing relief—the method in which the contours on one side of a hill are shown in black, and on the other side in white. It is now generally recognized that this is not a success, except, perhaps, in strongly marked country, which would show up well on any system. The examples given in the book make this plain.

In his treatment of heights and contours in general the author is not always happy. He speaks of the height of Everest as estimated. He defines mean sea-level as the mean between the heights reached by spring-tides and neap-tides. He says of the sea-level contour that "this line has no elevation, just as the equator has no latitude." He thinks that a country viewed from overhead would stand out

in bold relief. He uses a chain for spacing his contours in compass sketching, and defines a bench-mark as a starting-point in a line of levels. It is said that a river "always flows down the most gentle slope," and that a gradient is "the average rise in the slope between any two points on a map." The experiment on p. 4 is ill-devised; the vertical intervals should be given by an independent vertical scale. The contours shown at the south of Fig. 9A, said to be taken from an O.S. map, are curious if not impossible, and the omission of a 400-foot contour in the middle of Fig. 15A accentuates the improbability of the topography there represented.

An experienced teacher will know how to avail himself of the useful parts of this book, and to avoid the unsatisfactory. We regret that the existence of the latter makes a well-intentioned book unsuitable for use in schools.

'The Realm of Nature.' By Dr. H. R. Mill. (London: Murray. 2nd edit. 1913. Pp. xii, 404. *Maps.* 5*s.*) The second edition of this well-known work, deservedly one of the most widely read of modern geographical text-books, has received important revision throughout. A new chapter has been added on weather and storms, including the relation of weather to pressure, and the subject of forecasts. This replaces the shorter sections which covered these subjects in the chapter on climate generally in the first edition. A number of new illustrations have been introduced and old ones improved, and the book is now presented in decidedly more attractive styles of type, make-up, and general appearance. The demand for this new edition (in spite of the first having been frequently reprinted), and the advantage which has been taken of it, are matters for congratulation to both author and publisher.

GENERAL.

'Ancient Town-planning.' By F. Haverfield. (Oxford: Clarendon Press. 1913. Pp. 152. *Plans and Illustrations.* 6*s.*) The somewhat striking title of this small volume has not been idly given. There is a clear endeavour throughout to correlate the doctrines of modern town-planning with the practices of the Greeks and Romans, with illustrations drawn from a number of the best-known sites in various countries, including Britain. The results are full of interest, not only to the expert antiquarian, but to all whose interests have any antiquarian bent, and the numerous diagrams are so clear and good as to afford any necessary assistance in following the descriptions in the text.

'The Ottoman Empire, 1801–1913.' By William Millar. (Cambridge: University Press. 1913. Pp. xvi, 547. *Maps.* 7*s.* 6*d.*) This volume belongs to the well-known Cambridge Historical Series, edited by Dr. G. W. Prothero. It appears wholly to fulfil the requirements of a book of its type, with its fully analysed chapter-references, bibliographical references, adequate maps, and comprehensive index, and withal it is written readably. The introductory chapter summarizes the history of preceding centuries so far as necessary to the comprehension of that of the nineteenth and twentieth. To the political geography of the period, at all events in the narrower sense of the consideration of boundary-lines and their changes (whether proposed, as in the treaty of San Stefano, or actually carried into effect), full attention is given, and the maps, so far as this purpose is concerned, are admirably clear.

THE MONTHLY RECORD.

EUROPE.

Variations of Mean Sea-level in the North Sea and Baltic.—A new investigation of these variations, which have been the subject of a good deal of discussion by various writers, has lately been made by Dr. Brehmer, of Hamburg, who has summarized the results of his studies in the *Annalen der Hydrographie*, 1913, Heft 5. A good part of his work related to the mouth of the Elbe, where interesting facts were elicited as to the point-to-point variation of the date of the yearly maximum, as also of the amplitude of the yearly variation itself. Extending his investigations to the variations of level disclosed by the records at twenty different stations on the North sea and Baltic coasts, he subjected these to harmonic analysis, and gives the resulting values of mean sea-level at the several stations for each month of the years 1900–1909 in the form of tables. The yearly amplitude at all the stations proved to be roughly the same (6 to 8 centimetres), and allowing for the influence of local conditions, the yearly period was also found to be the same throughout, the maximum being reached in late September or early October. A half-yearly period with maxima early in February and August is also traceable. On examining the records of barometric pressure for the same ten years, Dr. Brehmer found a yearly period which took roughly the same course as that of mean sea-level, so that a connection might be supposed to exist between the two phenomena. Another explanation, however, and one to which he appears to attach greater weight, is to be found in the varying attraction exercised by the sun on the atmosphere and hydrosphere in different parts of the year.

Forestry in Switzerland.—The management of forests in Switzerland is conducted on so systematic a plan that much instruction is to be gained from a study of it. An account by Mr. W. Dallimore of a tour of inspection organized by the Royal Scottish Arboricultural Society, in conjunction with the Swiss forestry officials (*Kew Bulletin*, 1913, No. 7) is therefore of much interest. In a country of steep slopes like Switzerland forest regulation is undertaken not merely for the profitable supply of timber, but perhaps equally for protective purposes—the fixing of land on hill-sides, the provision of barriers to break the force of avalanches, the draining away of subsoil water with a view to preventing landslides, and the control of mountain streams. So beneficial is this work felt to be that even where the expenses are in excess of the income (as is sometimes the case) the burden involved is cheerfully borne by those concerned. The ownership of the forests is very various, some being in the hands of the Federal Government, others in those of individual cantons or towns, and others, again, of private owners; but all are subject to periodical inspection, such is the importance attached to the clothing of the steep mountain-sides by trees with a view to reducing the danger from landslides and avalanches. Again, while the villagers possess grazing rights in some forest areas, only cattle are now permitted among the trees; goats and sheep being excluded both on account of the injury done by them to the trees, and because of their proneness to climb precipitous slopes and loosen stones to the danger of the valleys. From the special descriptions of the forest areas visited, it appears that the methods vary in accordance with the local conditions—amount of rainfall, etc. Protective works include the building of retaining walls, and the formation of terraces on which trees can be planted where the slope is too steep for the purpose otherwise. Where the surface consists of crumbling rock the first vegetation to be

established is generally grass, which in some cases has been carried considerable distances in the form of turves cut in the lower grounds. The regulation of the streams is also carried so far that artificial falls and paved courses have been built in many cases. The results shown to have resulted from these various measures are most striking. Thus at Interlaken floods (from which the town once suffered severely) are now unknown. The devastation by avalanches and landslides has been checked at Mannlichen and elsewhere. At Brienz the violent waters of the Tracht-bach have been successfully regulated. One of the most interesting forests visited was the Sihlwald, the town forest of Zürich, which has belonged to the town for upwards of one thousand years, and has been in the main under a similar management since the fourteenth century. The trees most grown in the Swiss forests are beech (for firewood) and soft woods like spruce, silver fir, and Scots pine for building purposes. The group system of felling and regeneration has been introduced with great success, and on mountain-sides clear felling is forbidden by law. Forest roads for the extraction of the timber have been constructed on a large scale.

The Climate of South-East France.—In an unpretentious paper printed in the newly established geographical magazine edited in Grenoble by Prof. R. Blanchard, Mr. E. Bénévent has made a really important contribution to the study of rainfall in south-east France, between the Rhone and the frontier. The paper has an even wider scope than might be supposed from its regional application; it is, in fact, a detailed chapter added to the literature on the Mediterranean climate. It is possible here only to briefly notice the conclusions. Thanks to its situation, the south-east of France is traversed yearly by two rainy currents, the clouds of which burst during the period in which the land is becoming warmed—viz. from January to July—and return seawards when the temperature is falling—viz. from July to January. The one current comes from the Mediterranean, the other from the ocean, and both are commingled in certain transitional regions during May. The south-east of France may therefore be divided into five rain regions, as follows: (1) Mediterranean coast-line (Toulon); (2) Mediterranean hinterland (Apt); (3) seaward transitional zone (Gap); (4) landward transitional zone (Lyon); (5) continental zone (Bonneville). The thanks of all students of climatology are due to Mr. Bénévent for this conscientious and original work, contributions of the kind being only too scarce. It is only within the last few years that such detailed studies on restricted regions have been at the disposal of geographers. Other instances are those of MM. Blanchard, Dainelli, and Anfossi, the last named having quite recently given, in the *Memorie Geografiche* (Florence 1913), a paper entitled "La pioggia in Piemonte e nelle Alpi Occidentali.' M. Bénévent frequently mentions Anfossi's work; but he has directed attention also to various mistakes which occur in his paper.

ASIA.

Connection of the British and Russian Triangulation on the Pamirs.—Part III. of the 'Records of the Survey of India' has just appeared, and contains some interesting details regarding the survey work carried out last year by the late Lieut. H. Gordon Bell, R.E., on the northernmost frontier of India, south of the Russian Pamirs, an undertaking which was brought to an untimely close by Lieut. Bell's death from appendicitis close to the Mintaka pass. The operations had originally arisen out of a resolution passed by the International Geodetic Conference in 1909 to the effect that it was very desirable to effect a junction between the Indian triangulation and Russian work in the Pamirs.

Reconnaissances made during 1911—after the completion of observations which carried the Kashmir Principal Series to points not far south of Gilgit—showed that two out of three suggested routes for the connection were impracticable, but that the third would be feasible. It was thus arranged for secondary triangulation to break off from the principal series just south of Gilgit and to follow the Hunza and Kanjut valleys as far as the Kilik and Mintaka passes, and from thence to extend over the Taghdumbash Pamir to a junction with the Russian points. As far as Hunza the valley is comparatively open, and the hills, though difficult, not inaccessible. In the neighbourhood of Baltit, lofty snowy masses rise above the valley on both sides, and progress becomes much more difficult. In many places the pathway is carried along the face of precipitous scarps, supported, gallerywise, on iron or timber struts, and the constant steep ascents and descents make marching in the summer months most trying. After the flood-water in streams has subsided in about November, the hillside path over the difficult stretches is generally forsaken for the river-bed. Seven marches from Baltit the junction of the streams from the Mintaka and Kilik passes—both leading to the Taghdumbash Pamir—is reached at Murkushi. It was decided that Lieut. Bell and Mr. McInnes should march at once to the Russian points on the Beyik pass, and commence building and observing there, working gradually back to effect a junction with the triangulation which Mr. Collins and Mr. Abdul Karim were to carry as far up the Hunza valley as they could. In the meantime Mr. Abdul Hai was to effect a junction between the Kashmir principal series and the figures laid on by Collins in the Hunza valley. The various sections started from Gilgit early in June, but bad weather ensued, and Mr. Abdul Hai met with a mishap which necessitated his return to India. Lieut. Bell and Mr. McInnes marched through the Kanjut valley and over the Mintaka pass. The descent on the northern side brought the party into Chinese Turkestan and on to the Roof of the World. The valley was wide and open, and covered with green grass, where many yaks were grazing. Some way down they were hospitably entertained at an encampment of Sarakulis—a fine big race, very cheery and good looking. On June 21 Bell moved towards Beyik on the Russian side, and on July 9 he was received and entertained by the Russian officers. Bell wrote, "We were very merry, and they most hospitable. I had to write my name in their pocket-books, and they in mine. We adjourned to photograph each other, and returned for more refreshment. Then they escorted me back to the pass, and we parted the best of friends. So now I have been into the trijunction of the 'three empires,' and to the most northern point the survey of India has reached." Only on July 11 he wrote in his letters, "I am very fit, and have quite got my mountain legs and feel full of work." But on the 19th he was seized by an attack of appendicitis, and though his companion, Mr. McInnes, came to his assistance, he became gradually worse and died on the 25th. There is an excellent photograph of Lieut. Bell in the volume of the 'Records,' another of the group of Russian and British officers, and also some excellent views of the Hunza gorge and other notable spots in the scene of the triangulation.

North-East Frontier of India Exploration.—According to the *Pioneer* of January 9, 1914, the work of exploration and survey on the North-East Frontier is being carried on this cold weather. A small expedition has entered the country of the Akas, the most westerly of the Abor Mishmi group of tribes. The Aka country has not been entered by a British party since the punitive expedition of 1884 paid it a flying visit.

French Railway in Western China.—It is announced that a preliminary agreement was signed in Peking on January 21, between the Minister of Communications and the Banque Industrielle, providing for the extension of the French-Yunnan railway to Chungking on the Yangtse. Such an extension has long been held in view by advocates of French penetration in Western China, being considered a necessary complement to the existing line, if the most important commercial field in that part of the Empire is to be exploited in the French interest.

AFRICA.

A Visit to Jarabub, the Senussi Mecca.—Towards the close of the Tripolitan War, a Turkish mission was sent to enlist the sympathies of the Senussi, and Dr. Abdul Ghani, of the mission, has supplied some notes to *l'Illustration* for February of this year regarding the oasis of Jarabub, which has rarely been visited by Europeans. Jarabub, known to the local Arabs as Jaaghub, lies on the edge of the Libyan desert, about eleven days' march from Derna. It contains the tomb of the founder of the Senussi sect, Sidi Muhammad es Senussi, who made it his headquarters in 1858; but the present Senussi has retired to the more inaccessible oasis of Kufra, and Jarabub remains as a place of pilgrimage for the sect, containing now only some 350 inhabitants. The surrounding tribes send a certain number of their children to a "medresse" or school attached to the mosque, and even these have to bring their food with them. There are eighty black slaves who tend the mosque, the tomb, and the few palms which constitute the garden. The great mosque is extraordinary for the Libyan desert, and has a rectangular court bordered by arcades, which gives access to the chamber in which is the tomb of the founder. The present Senussi, Sidi Ahmed esh Sherif, is a man of middle age, who keeps up considerable state. There are altogether 140 Senussi "zawias" in Africa, of which about a dozen are said to be in Egypt, six in the Tripolitaine, and the rest in Cyrenaica and the Sudan. There are doubtless some others in Arabia. The mission reached Jarabub from Derna, on the coast, after a journey rendered difficult by lack of water. The first camp was at the "zawia" or Senussi monastery of Iziat, a few huts with forty inhabitants. South of this extends a gently undulating plain, with but an occasional tuft of vegetation. Gazelle and hares were abundant, and on nearing Jarabub, the oryx with short straight horns was found in considerable numbers. After four days of waterless desert, the cisterns of Uquaim are reached—some choked with sand—the largest measuring 130 by 26 feet, and covered by an immense slab of rock. The water here is of excellent quality, and has never been known to fail. The cisterns were constructed in the Greco-Roman period, and when all five were in use, the traffic on the route must have been considerable. Five days south of Uquaim the sands of the desert give place to the more rocky plateau of Deffe, with the sulphurous-saline wells of Saniet-ed-Deffe, palatable only to the camels. Soon after this the stone houses and mosque of Jarabub appeared suddenly over a rising ground. From Jarabub direct to Kufra is said to be nine stages; but practically this means marching night and day, while in summer water has to be carried for the entire distance. At that season the usual route from Kufra is that through Jalo to Benghazi, followed by Rohlfs in 1879, and on this water is to be obtained from wells at long intervals. South of Kufra, a desert route leads towards the French Lake Chad territory, the outposts of which, since the capture of Ain Galaka by Colonel Largeau last November, have been pushed up to Guro, on the eastern slopes of the Tibesti mountains, closing this Kufra

route on the French side. On the north it is rumoured that an Italian expedition is preparing to attack the Senussi from bases in Cyrenaica, so that possibly this secluded retreat of Moslem fanaticism may at last succumb to the advance of civilization.

The Harmattan Wind of the Guinea Coast.—The *Quarterly Journal of the Royal Meteorological Society* for October, 1913, has an article on this subject by Mr. H. W. Braby, who discusses observations of the wind made at Zungeru, Northern Nigeria; producing tables showing the meteorological conditions accompanying it for each month in the five years 1907–1911. Much has already been written on the subject, but it is only lately that sufficient observations have accumulated to admit of trustworthy conclusions. As is well known, the Harmattan is an exceedingly dry wind, blowing intermittently during the winter months from November to March in the coastlands of Upper Guinea from French Guinea to the Kamerun. It brings much dust, doubtless from the Sahara, which partially obscures the sun together with distant objects. It is, however, on the whole salubrious and is locally known as "the doctor." The direction of the Harmattan is almost invariably from the north-east, and its quality is somewhat that of a Föhn, blowing likewise from higher to lower regions. The exceedingly dry character of the wind is very conspicuous, but there is a seasonal variation in this quality, and the stronger the wind the lower the humidity. In November, December, January, and February 1909–10 the mean relative humidity on days of no Harmattan was respectively 77, 54, 36, and 46, whereas for the days with Harmattan the figures were 55, 44, 33, and 30. During the Harmattan season the tables show a considerable range of temperature, although this fact has probably little connection with the wind, showing only a seasonal variation, the range of temperature being less in summer. The direction of the Harmattan involves the occurrence of a relatively high barometric pressure to the north and a low one to the south. In winter the equatorial low-pressure belt is at its southern limit, a circumstance which helps to establish a gradient for a north-easterly wind along the Guinea Coast. The Harmattan is a very important factor in the climate of Zungeru, and a note of its prevalence and character forms a prominent feature in the meteorological returns which are regularly sent to the Meteorological Office, by the Chief Secretary to the Government.

The Tanganyika Railway.—The arrival of the rail-head of the German Tanganyika railway at its terminus at Kigoma, a little north of Uiji, was announced on February 2 as having taken place the day previously. Thanks to the energy with which the work on the last section of the great undertaking—from Tabora to the Lake—has been prosecuted, the work has been completed fourteen months before the date specified in the contract. It was only in July, 1912, that the extension to Tabora of the initial section of the railway—begun, after long discussions, in 1904—was completed, though measures had even then been adopted for taking in hand the final section. Some account of the history of the undertaking and of the route followed by the line was given in the *Journal* for May, 1911 (vol. 37, p. 563).

AMERICA.

Surveys in Hudson Bay and Strait.—The hydrographical work undertaken by the Canadian Department of Naval Service in Hudson bay and strait, to which reference was made in the *Journal*, vol. 41, p. 286, was continued in 1912 by various parties, reports on whose work appear in the Report of the Department for the year ending March 31, 1913. The largest party, under Mr.

Frederick Anderson, was engaged in extending the survey of Nelson river and also in Hudson strait, and his report contains valuable matter bearing on the navigation of the waters examined and especially the ice-conditions. As in the previous year, the ice-breaker *Minto* was loaned by the Department of Marine and Fisheries, and it was in charge of Captain S. W. Bartlett. Choosing a track in the light of experience gained the previous year, the *Minto* (which had left Halifax on July 24) encountered less ice than any vessel entering the bay throughout the season. The Moravian Missionary at Port Burwell (just within the entrance to the strait, on the Labrador side) reported that the winter had been very mild and that a vessel could have entered the strait as early as June 15. Port Nelson was reached on August 6, and survey work was carried on off Nelson roads until the end of September. Mr. H. H. Lawson, who had been sent overland in charge of a shore party at the end of February, was found at the Nelson river, and reported that cracks first appeared in the river-ice about May 15, tide being first noticed on the 18th. During the break-up, no great shoving or crushing was noticed, the river breaking up as quietly as a lake. The entrance does not generally freeze up until the end of the year, and occasionally remains open the whole winter. On the return voyage, which was uneventful, surveys were carried out in Hudson strait, and a fair anchorage was discovered among the Button islands. When off Mansel island, on November 2, no ice was visible from the mast-head, though it was the latest date on record for any steamer to be in that locality. As a result of this and previous work, there is now sufficient information to give a fair idea of the general ice-conditions, and of the period during which navigation can be carried on with comparative safety. A second report of some interest is that of Mr. H. D. Parizeau, who was entrusted with a survey of the shores of James bay (particularly of its south-eastern extremity, Rupert bay) with a view to finding a suitable location for a railway terminus, and also collecting information on the ice and weather conditions and the natural resources of the district. He describes the various river entrances, and mentions several spots suitable for harbours, besides discussing the ice-conditions and possibilities of navigation. In winter James bay is practically frozen over, but little has hitherto been known of the movements of the ice in the spring and autumn. The impressions gained as to the climate and agricultural possibilities appear to have been favourable on the whole. A table is printed (compiled by an officer of the Hudson Bay Co.), giving dates of arrival and departure of ships for every year from 1751 onwards.

Ponce de Leon's Discovery of Florida.—Much as has been written on the voyage of Juan Ponce de Leon and his quest of the fountain of perpetual youth, few have attempted to trace in detail the course sailed by him in his voyage, no doubt owing to the insufficiency for the purpose of the one account that has reached us—that of the historian Herrera. The attempt has now been made by Dr. L. D. Scisco in the *Bulletin* of the American Geographical Society for October, 1913, largely on the basis of the delineation of Florida and neighbouring islands by Conte O. Freducci in his map of about 1514–15, of which a reproduction was published in 1894 by Casanova. This map—at least that part which deals with Spanish America—is evidently based almost entirely on Spanish sources, among which Dr. Scisco would place the actual charts resulting from Ponce de Leon's voyage of 1513. He takes Herrera's account of the voyage passage by passage, endeavouring to identify each successive point touched at, first in the passage from Porto Rico along the outer margin of the Bahama group to its northern extremity; next during

the stay on the east and west coasts of the Florida peninsula and among the Florida Keys; and lastly during the search for the rumoured island of Bimini in the area between the Great and Little Bahama banks before the return voyage was begun. The identifications seem generally plausible, and are in many cases based on a study of the local conditions—the possibility of shelter offered by different parts of the coast, and the like, though possibly too much weight may sometimes be given to chance resemblances between the trend of the coasts as shown by Freducci and the reality. Statements of the latitude are also used, but with a systematic correction in accordance with the view that the latitudes given showed an increasing excess over the reality as the explorer advanced northward. Dr. Scisco would seem to have hardly sufficient ground for assuming that the error increased in a regular ratio, though the assumption certainly gives results which harmonize well with probability on other grounds. The landfall on the east coast of Florida is placed by this method in 27° 40′, a little north of Indian river inlet, instead of in 30° 8′, as by Herrera. In a similar way the Cabo de Corrientes, which has been identified by some with Cape Canaveral, becomes a point near Lake Worth inlet, considerably farther south, while the voyage is not supposed to have reached Cape Canaveral at all. The identification of Rio de la Cruz with Jupiter inlet on the strength of the chart record of the cruciform shape is hardly convincing.

POLAR REGIONS.

Mr. Stefansson's Expedition.—Down to the middle of February no intelligence of the missing vessel of Mr. Stefansson's expedition, the *Karluk*, which disappeared in a gale last September while the leader was absent on a hunting expedition (see January number, p. 85), had been received in Toronto. In a letter to the Department of Naval Service, supplementing his previous telegram, Mr. Stefansson reiterates the opinion that the vessel is in no great danger, though fears have been expressed in other quarters, particularly by Bishop Rowe, of Alaska, who was at Toronto in February, that the vessel may have been crushed by the ice owing to the unusual severity of the season. Even in this case it is hoped that the crew may have reached land. The reports of disaster to the smaller vessel, the *Mary Sachs*, are reported to have been unfounded. At the time of writing Mr. Stefansson had obtained equipment at Point Barrow sufficient to take him to Collinson point, the winter quarters of the southern section of the expedition.

New Swedish Antarctic Expedition.—A scheme has been set on foot in Sweden for the resumption of Antarctic exploration on the part of that country by a new expedition to Graham Land, to continue the work of Dr. Otto Nordenskjöld. An influential committee, formed last year, favours the despatch, in the autumn of 1915, of ten scientific men for research in that region, to be continued for five years. Half of the required funds (£15,000 in all) are being provided by the Swedish Government.

Argentine Station in the South Orkneys.—A new staff of meteorologists left Buenos Aires in January for the South Orkneys, under the direction of Richard Blüthgen, a German. They are being conveyed to their post in the fishing steamer *Harpon*, which will bring back the observers who have been at work at this solitary station during the past year.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Volcanic Dust as a Factor in the Production of Ice Ages.—A discussion of this complicated physical subject, by Mr. W. J. Humphreys, constitutes vol. 6,

pt. I., of the *Bulletin* of the Mount Weather Observatory (U.S. Department of Agriculture). After reviewing the principal theories which have been launched to account for ice-ages, Mr. Humphreys goes on to consider mathematically the possible effect of volcanic dust in bringing about some of the Earth's past climatic changes, more especially those marked by glacial periods. The dust in question is the very fine sort which is thrown into the upper atmosphere by great volcanic eruptions, such as those of Skaptar Jökull and Asamayama in 1783, Babuyan in 1831, Krakatao in 1883, Santa Maria and Pelée in 1902, Katmai in 1912, and many others. This dust once thrown into the upper atmosphere—into the strato-sphere or isothermal region—out of the reach of vertical circulation, takes a very long time, on account of its slow descent, to get back to the Earth—it may be two or three years. With the potentiality of this high-suspended volcanic material for altering the temperature of the surface of the Earth by the interception of the sun's radiation, Mr. Humphreys' treatise mainly deals. He produces many equations representing the effect of the absorption, radiation, reflection, and scattering of solar radiation by the dust particles, and shows that the total effect of these processes must be such that "a change of 10 per cent. in the radiation emitted would imply 6·4° C. change in temperature, an amount which, if long enough continued, would be more than sufficient to produce glaciation equal to the most extensive of any known ice age." The theory is tested by the production of various curves indicating the relationship between the general temperature of the Earth, the intensity of solar radiation, and the incidence of great volcanic explosions during the past century, and it is noteworthy that a depression in both curves occurs after every volcanic outburst, including the recent one of 1912 in Alaska. Altogether the various results are mutually confirmative of the view that volcanic dust is a potent factor of climatic variation, and that, apart from other influences, the Earth possesses potentially the power of bringing about its own climatic changes—even of beginning and ending its own ice ages. "It has been clearly shown," says the author, "among other things, that volcanic dust in the high atmosphere decreases the intensity of solar radiation in the lower atmosphere and therefore the average temperature of the Earth, substantially as theory indicates *a priori* that it should; and this effect has been clearly traced back to 1750, or to the time of the earliest reliable records." Of the other theories that have been advanced to account for glacial epochs, the only one to which we are inclined to attach much importance is that of variations in the output of solar energy, but, as Mr. Humphreys points out, this theory is secure from all tests, there being no evidence for or against it, and its value at present may be said to depend on the untenability of those other possible theories. We would particularly draw attention to the fact that the dust action in question refers to the regions of the atmosphere above the theatre of weather changes wherein our cloudscapes are depicted.

GENERAL.

British Antarctic Expedition, 1910–1913: Honours to Captain Scott and Commander Evans.—At 10 a.m., on February 5, the inauguration of the monument erected to the memory of Captain Scott and his brave comrades, on the initiative of Dr. Charcot of the French Antarctic Expeditions of 1903–5 and 1908–10, took place at the Lautarets in the heart of the Alps of Dauphiné, at an altitude of 6500 feet, amidst glorious sunshine. The extreme simplicity of the monument is in itself imposing, and the grandeur of the mountains surrounding it forms a striking background. It consists of a cairn of rocks with a mast, resembling the burial cairn at Captain Scott's last camp on the Great

Ice Barrier (see *Geographical Journal*, vol. 41, p. 486, and vol. 42, p. 578). The ceremony commenced by a salute from the bugles of the Alpinist soldiers, who formed part of a company sent by the French Military authorities. Dr. Charcot, speaking with great emotion, paid a touching tribute to the memory of Captain Scott, whose death for his country and science would never be forgotten. Captain Scott was his very great friend with whom he had tested motor sledges on the very site of the monument. Dr. Charcot then formally handed the monument to the care of the University of Grenoble. General Parreau, governor of Briançon, stated that the army was proud to be associated with the inauguration. Staff-paymaster Francis R. H. Drake, R.N., F.R.G.S., who represented the Antarctic Expedition of 1910–13 and the Royal Geographical Society, thanked Dr. Charcot and his companions on behalf of the Expedition, stating that Captain Scott's name for Dr. Charcot, "Gentleman du Pole," would always be remembered by the members of the expedition. Staff-paymaster Drake concluded by stating that he had been requested to convey the Royal Geographical Society's warm appreciation of the great honour the French had paid to the memory of Captain Scott and his brave companions. The Alpine troops presented arms, the buglers sounded a salute, when two of the soldiers hoisted the flags of the two nations on the mast of the cairn; the spectators, about 150, standing with bared heads. When the troops had marched round the monument, the ceremony ended. Mr. Lewis, the British Vice-Consul of Grenoble, was also present, with many scientific representatives, including M. Rabot, of Paris. A banquet was served at the Hotel du Lautaret, during which Dr. Charcot read a letter from Lord Curzon, President of the Royal Geographical Society, thanking him on behalf of the Society. Commander E. R. G. R. Evans, C.B., R.N., who has been lecturing both at home and on the continent on "The British Antarctic Expedition, 1910–1913," has received, as representing the expedition, many honours; from the Geographical Societies of Antwerp, Christiania, Gothenburg, Stockholm, Copenhagen, Rome, Vienna, Budapest, Berlin, he received diplomas of honour; in Paris he received the Gold Medal of the city, and was made officer of the Legion of Honour; from Edinburgh, Newcastle, Marseilles, Budapest, Brussels, he received Gold Medals. The Geographical Society of Vienna has awarded a Medal to the memory of Captain Scott, which will be sent to the Royal Geographical Society for presentation to Lady Scott. The 42nd Company of Senior Cadets of Queenstown, Lake Wakatipu, New Zealand, have erected a memorial to Captain Scott and his companions, consisting of two tablets placed on a big boulder transported from the Humboldt mountains by the great Wakatipu glacier that at one time occupied the whole of the lake basin.

London Memorials to Captain Scott.—The Committee of the Captain Scott Memorial Fund has appointed a sub-committee, to which will be entrusted the provision of suitable memorials in London to Captain Scott and his companions. In St. Paul's wall-space for a bronze tablet or bas-relief has already been assigned, and the design has been entrusted to Mr. S. Nicholson Babb. For the proposed outdoor group of statuary a site will probably be chosen either in one of the parks or in the grounds of Greenwich Hospital, and designs have been invited from six well-known sculptors. The sum of £7500 has been set apart for this latter purpose.

OBITUARY.

Sir David Gill.

We record the death of Sir David Gill with a deep sense of the loss which befell Geography when the world lost her most distinguished astronomer.

During the whole of his official life he was H.M. Astronomer at the Cape of Good Hope. He found the observatory there, on his arrival in 1879, a poorly equipped and shabbily maintained institution. During the tenure of his office he was able to persuade the Admiralty to such effect that when in 1906 he resigned his post for reasons of health and returned to England, he left the Cape Observatory with an equipment which in breadth and refinement is unrivalled. There are individual bigger instruments, but there is no other observatory equipped like the Cape for work of high precision on every side.

And happily for Geography, Sir David Gill's interest extended far across the ill-defined territory that separates Astronomy and Geodesy. In his early life, before he was yet in official service, he had contributed to Geography a series of longitudes exceptionally precise, determined primarily for the operations of the parties sent to observe the transit of Venus in 1874, and for his measure of the solar parallax at the island of Ascension in 1877. The chain of longitudes, Greenwich—Berlin—Malta—Alexandria—Suez—Aden—determined telegraphically by Gill in 1875, in co-operation with the Germans, has played a strong part in subsequent operations throughout the East and South. His longitude of Mauritius has never been repeated, and serves as the datum for surrounding longitudes to this day. On his way home he accepted the invitation of the Khedive to measure a base near the Great Pyramid for a projected survey of Egypt, and this experience doubtless stood him in good stead in after years.

The next years were occupied with his expedition to Ascension—perhaps the most fruitful one-man enterprise ever carried out. Its interest, however, is all astronomical, save for the charming account by Lady Gill of 'Six months in Ascension,' which has found a wide circle of readers. Then in 1879 he was appointed to the Cape Observatory. Very soon he began to study the question of a Geodetic Survey of South Africa. "The traditions of his office," he wrote, "appeared not only to justify but to demand that some portion of his time and attention should be devoted to this work. Sir Bartle Frere was then Governor of the Cape Colony and High Commissioner for South Africa. From his experience of Indian administration his Excellency thoroughly realized the advantages of and the necessity for accurate survey, and the true economy of basing all future surveys upon a principal triangulation of such accuracy that its results might be considered definitive for all future time, and he gave Gill's recommendations his strongest and most cordial support."

A full history of the long operations that ensued may be read in the volumes of the Geodetic Survey of South Africa, which must be studied by any one who wishes to appreciate the difference between the geodesy of the middle and of the end of the nineteenth century. A summary of the work is contained in the 'History of the Cape Observatory,' which Gill completed and saw published only a few weeks before his death. Two technical details only must find place here: he was early in the field with the use of the Jäderin wires for base measurement; and his strong common sense insisted on giving each observed angle a uniform weight, thereby sweeping away at one stroke a great deal of the

complexity of computation familiar to those who have studied the volumes of the principal triangulation of the Survey of India.

The Geodetic Survey of South Africa soon led to a grander scheme: the measure of the 30th meridian of East longitude, from Port Elizabeth to the mouth of the Nile, and eventually through Asia Minor to connect with the great European arc on the same meridian which terminates at Hammerfest. How a strong will and enthusiasm can carry through an arduous and expensive scheme in despite of war and the consequent financial stringency is told with all simplicity in the History cited above. Cecil Rhodes was converted as early as 1894, and by 1897 the Chartered Company was in a position to prosecute the work effectually. In 1902 Lord Milner was convinced of the need for authorizing the geodetic survey in the Transvaal and the Orange River Colonies. While this was being done the triangulation of Rhodesia was pushed on towards Lake Tanganyika, and was finally closed down a little south of the lake. The last stage of the whole was the linking up of the Transvaal and Rhodesia by the arc from the Limpopo to Gwelo. Rhodes was dead: the British South Africa Company not unnaturally felt that it had done as much as it could afford; and there seemed to be every probability of a link being lost, when at the instigation of Sir George Darwin several learned societies, of which our own was happily one, came to the rescue and persuaded the company to take equal shares with them in completing the work. Thereupon there passed the two telegrams which will remain historic:

"*Inform Sir David Gill from Darwin* £1600 *has been granted only provided he guarantees finish connection.*

"*Gill accepts responsibility acts of God and the King's enemies excepted.*"

The Geodetic Triangulation of South Africa is Gill's imperishable monument. While his most refined astronomical determinations may in time be partially superseded or surpassed by later work, the triangulation which he carried through South Africa to Lake Tanganyika will be for all time the backbone of the topographical surveys that will depend upon it. So long as due care is taken to preserve the station marks—and that is a duty which the Government cannot in honour neglect—every subsidiary chain of triangles can be connected with the main chain. Thus surveys under different administrations can be pursued effectively and cheaply, and with the certainty that they will fit precisely into the general scheme, without difficulties and discontinuities at the junctions. When the Union Government is at last either willing or compelled to take up the long neglected topographical survey of the Transvaal and of Natal it will be found how great was the advantage accruing to the Empire in South Africa by Gill's broad statesmanlike conception of his duty to the British Admiralty and people.

In 1906 Sir David retired from his office at the Cape, and settled down in London to a strenuous enjoyment of his leisure, working as hard as ever. He served a term on the Council of this and of other societies; represented Great Britain on the Committee of the International Bureau of Weights and Measures, and at the International Time Conferences; and was Honorary President of the permanent committee of the Astrographic Chart. He undertook the design and superintended the construction of new comparators and base apparatus for the Survey of India and for the Government of New South Wales, as well as of many instruments for the observatories of Russia and Chile. On everything to which he turned his hand he left the mark of a genius for instrumental refinement, which has, perhaps, never been surpassed.

In looking back over his full and successful life, one is struck by his power

of carrying whatever he began to a successful conclusion. His enthusiastic nature led him to take an eager interest in very varied lines of work, and he was always full of plans. But it does not appear that he ever started a thing which he did not pursue to the end, and almost invariably to a successful end. Thus it has come about that his various works stand complete. His great astronomical enterprises are complete, when they were personal; or are in full activity and vigour, when they are greater and semi-permanent things like the Astrographic Chart. His arc of meridian is complete and fully worked up to its end near Tanganyika. It stands ready and waiting for the extension through German East Africa to join the section already measured on the Uganda-Congo frontier; and it has already been brought into discussion for a figure of the Earth in an interesting and valuable paper by Dr. Wilhelm Bahn, published in *Beiträge zur Geophysik, Band* 10, 1910, and translated for an appendix to the 'History of the Cape Observatory.'

Sir David Gill had but recently been appointed to succeed the late Sir George Darwin as British representative on the International Geodetic Association. His unique experience of recent geodetic operations and his world-wide renown would, it was hoped, support and advance the high position which Sir George had won for Great Britain in the councils of that Association. The public loss is great. What cannot be written is the loss to those who were privileged to be his personal friends and to enjoy his ever-ready help.

Lord Strathcona.

Lord Strathcona, who died in London on January 21 last, was one of the makers of modern Canada. Though he did not originate the scheme for the linking of older Canada to British Columbia by railway, it was almost entirely due to his energy, his unwavering determination, and his genius for finance that the transcontinental line was completed in 1885 and the way paved for the vast development of the Dominion that has followed.

Born at Forres, Elginshire, in 1820 (or perhaps in 1818, the date is not certain), Donald Alexander Smith was of pure Highland blood. In 1837, through the recommendation of his maternal uncle John Steward, a well-known fur trader, young Smith entered the employment of the Hudson Bay Company and sailed for Canada. From that date until 1869 he served the company in Labrador and the North-West territories. Life in those remote regions was one of much hardship and great isolation—factors which make, as in Donald Smith's case, strong men stronger. He gave much energy to enlarging the resources of the country, introducing, for instance, in Labrador the cultivation of the potato and other vegetables. For his own mental cultivation in the wilds he had a small library—the Bible, Shakespeare, Boswell's 'Life of Johnson' and Pitt's 'Speeches.'

In 1869 Smith became governor in North America of the Hudson Bay Company, which at that time parted with its proprietary rights to the state. The revolt of the Red river settlers under Louis Riel was one result of that transfer. Smith went as special commissioner to Fort Garry (the site of Winnipeg) and by adroit and courageous handling of the situation successfully checked the rebellion. In 1871 he entered the Dominion House of Commons, and continued in political life in Canada until his appointment as High Commissioner in London for the Dominion. This post he held until his death. It was in 1880 that Smith and his colleagues (the proposal to construct the line as a State enterprise

having failed) obtained the contract for building the Canadian Pacific Railway. The work was carried on with such energy that it was completed seven years in advance of contract time. Offical recognition of his services followed; in 1886 he was made K.C.M.G.; on becoming High Commissioner he was promoted G.C.M.G., and in 1897 he was created Baron Strathcona and Mount Royal. A man of great will power, simple and modest in his private life, he attributed his good health and his longevity to the fact that he always worked hard. Much of his great wealth he expended on public objects, such as the endowment of universities and hospitals. At a cost of £200,000 he sent "Strathcona's Horse" to take part in the Anglo-Boer War of 1899–1902.

A fellow of this Society since 1883, it was through Lord Strathcona's instrumentality that the Canadian Government was induced to make a grant of £1000 to the Society's building fund.

CORRESPONDENCE.

Relief in Cartography.

Ordnance Survey Office, Southampton, January 14, 1914.

As I was unable to be present at Captain Lyons's interesting lecture on "Relief in Cartography," a proof of which I was glad to receive, perhaps you will allow me to make a few remarks on it, especially with reference to the methods of relief adopted for the Ordnance maps of the United Kingdom.

Captain Lyons's criticism of the ½-inch Ordnance map reads: "a shading was added to increase the relief effect and does so at the cost of obscuring the detail on the steeper slopes. A more serious objection, however, was the use of solid or nearly solid shades of a dark neutral tint for the highest zones . . . so that the hilltops so coloured appear to recede. . . . , and give rise to the effect of depressions." I have spoken to Captain Lyons with regard to this criticism and he tells me that it was intended to read in the past tense. I should, however, like to make it quite clear that the edition described is not the present Ordnance Survey ½-inch, which has neither added shading nor neutral tint. The edition referred to was rendered obsolete two years ago, and is now almost entirely superseded. The new edition, which was not referred to by Captain Lyons, has a colour scale of greens, through buffs to warm browns, and, so far as I am able to ascertain, it is generally considered satisfactory.

Captain Lyons did not mention the latest Ordnance map, namely the 1-inch coloured map of the Killarney district, which, though to some extent produced as an experiment, seems to have met many of the objections raised with regard to the use of colour and shade. I was glad to see that Prof. Davis approved of the general effect, though I agree with him that the representation of the Gap of Dunloe could be improved.

I should like to add, with reference to Captain Lyons's remarks on the colour scale for the International 1 : 1,000,000 map, that the official conference held at Paris in December last amended the scale generally in the direction desired by him. The amended colour scale will, it is hoped, be published in the course of a few months.

C. F. Close,
Colonel, Director-General, Ordnance Survey.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1913–1914.

Sixth Meeting, January 26, 1914.—The Right Hon. Earl Curzon of Kedleston, G.C.S.I., G.C.I.E., etc., President, in the Chair.

Elections.—*Miss A. Balthazar; Lieut. Francis Joseph Bayldon, R.N.R.; Captain Stanley Welch Beeman (8th King's Regiment); Francis Patrick Bray; Brig.-General E. B. Burton, C.B.; Lord Congleton; Rev. Alexander Robert Crawford, M.A.; Rev. Harold Stephen Blythe Critchley; Miss Isabel M. Entwisle; W. Ludford Freeman (Director of Education), M.A., LL.D.; James Edwin Gill; Thomas William Glare, B.A.; Captain Bryan Godfrey-Faussett, R.N. (Retired); Harold Greenhaugh, B.A.; Laurence D. Gurrin; Prof. Hertig; Mrs. Henry Hobhouse; Edward Hudson; Miss Katherine Lillingston; Charlotte Mansfield; William Henry Matthews; B. E. Mitchell, M.A.; Graham Morrison; William Purdon; J. Grant Ramsay; Lieut.-Colonel Arthur Johnstone Richardson (East Yorkshire Regiment); Miss Agnes Robertson, M.A.; H. Gordon Selfridge; William Sparks; Major J. C. B. Statham; Lieut. Frederick Sudell, R.N.R.; Ralph Neville Thurston; Harold Abbot Titcomb; Lady Ethel Turing; Charles A. Werner; Sydney B. A. Wilkinson; C. S. Wright.*

The paper read was:—

"Exploration in Dutch New Guinea." By A. F. R. Wollaston.

Seventh Meeting, February 9, 1914.—Major Leonard Darwin, Vice-President, in the Chair.

Elections.—*Charles Selwyn Duncan Griffith Boyes; Richard Burbridge; Captain Mitcalfe Dale (late 10th Regiment); Captain Richard Long Dawson; Clarence Fahnestock; A. H. Flowerdew; Lieut. Aveling Moffat Ponton Ford, R.N.R.; Cyril Gamon; Donald George Hill; Captain H. Treise Morshead, R.E.; E. C. Mulvey; Commander John Dodd Nares, R.N.; James William Parkes; Lieut. William Frederick Pearce, R.N.R.; Miss Hilda A. S. Perry; Mrs. Elizabeth Beatrice Powell; Alexander Galt Ross; G. A. H. Samuel; Major-General Sir Reginald Talbot, K.C.B.; Griffith Taylor; Captain James W Truman, R.M.S.; William De Hertburn Washington; Mrs. Clare Hamilton Watson.*

The paper read was:—

"Our Present Knowledge of the Antarctic and the Problems that Remain to be Solved." By Prof. Edgeworth David, C.M.G., F.R.S.

Eighth Meeting, February 17, 1914, in the Queen's Hall.—The Right Hon. Earl Curzon of Kedleston, G.C.S.I., G.C.I.E., etc., President, in the Chair.

The paper read was:—

"Some Aspects of Travel." By Rudyard Kipling.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
Jber. = Jahresbericht.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society; Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is $10 \times 6\frac{1}{4}$.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Balkan Peninsula—Territorial changes. **Thomasson.**

Questions Diplomatiques **36** (1913): 193–200.

La paix de Bucarest. Par Commandant de Thomasson. *Sketch-map.*

Denmark—Pilot. **K. Sökort-Arkiv.**

Den Danske Havne-Lods; udgivet af det Kongelige Søkort-Arkiv. Syvende udgave; sluttet den 15. Juni, 1913. Copenhagen, 1913. Size $10 \times 6\frac{1}{2}$, pp. 176. *Plans. Presented by the K. Danske Søkort-Arkiv.*

Europe—Gravity and Mountain Ranges. **Costanzi.**

La distribuzione della gravità in Europa specialmente in relazione coi sollevamenti montuosi. Da Giulio Costanzi. (From 'Rivista di Fisica, Matematica e Scienze Naturali' (Pavia), Anno XI., Num°. 122–125, 127–129.) Pavia, 1910. Size 10×7, pp. cxxiv. *Maps.*

Europe—Mammals. **British Museum (Natural History).**

Catalogue of the mammals of Western Europe (Europe exclusive of Russia), in the collection of the British Museum (Natural History). By Gerrit S. Miller. London: British Museum (Natural History), 1912. Size $9 \times 5\frac{1}{2}$, pp. xvi. and 1020. *Illustrations. Presented by the Trustees.*

Europe, South-East—Phytogeography. **Adamović.**

Abh. k.k. G. Ges. Wien **10** (1913): No. 3, pp. 61.

L. Adamović. Die Verbreitung der Holzgewächse in den Dinarischen Ländern. *Map and Illustrations*

Finland. **Leclercq.**

Jules Leclercq. La [illegible]nde aux mille lacs. Paris: Plon, 1914. Size $7\frac{1}{2} \times 5$; pp. iv. and 282. *Map and Illustrations. Presented by the Author.*

France—Alpes Maritimes—Vegetation. **Tessier.**

La G., B.S.G. Paris **28** (1913): 119–125.

La végétation des Alpes maritimes. Par L. F. Tessier.

France—Dordogne. *B.S.G. L'Est* **34** (1913): 5–13. **Fourgous.**

La vallée préhistorique de France. La Vézère aux Eyries. J. Fourgous. *Illustrations.*

France—Landes—Coast. *Rev. G. Com. Bordeaux* (1913): 125–142. **Saint-Jours.**

La fixité de la Côte landaise. Dunes et Étangs. Par B. Saint-Jours. *Sketch-map.*

Greece—Corinth—Geology. **Depéret.**

C.R.A. Sc. Paris **156** (1913): 427–431, 659–663, 1048–1052.

Observations sur l'histoire géologique pliocène et quaternaire du golfe et de l'isthme de Corinthe. Par Charles Depéret.

Italy—Venice—Hydrology. **R. Magistrato alle Acque.**

R. Magistrato alle Acque. Ufficio Idrografico. Pubblicazione N. 54. Studi fitogeografici sulla laguna di Venezia. Venice, 1913. Size 10½ × 7, pp. viii. and 348. *Sketch-map and Illustrations in separate cover.*

United Kingdom—Gazetteer. **Bartholomew.**

The Survey Gazetteer of the British Isles, topographical, statistical, and commercial, compiled from the 1911 Census and the latest official returns. Edited by J. G. Bartholomew. Edinburgh: J. Bartholomew & Co., 1914. Size 10½ × 7, pp. viii. and 756. *Maps. Price* 15*s. net. Presented by the Publishers.*

This most useful gazetteer has been entirely reprinted, and the statistical information revised throughout; fresh names have also been inserted in certain places. The volume as a whole, notwithstanding the alterations, is much reduced in bulk. It is to be regretted, however, that the very useful series of economic maps in the first edition have not been retained.

United Kingdom—Ireland—Place-names. **Joyce.**

The origin and history of Irish names of places. By Dr. P. W. Joyce, 3 vols. London: Longmans, Green & Co., 1910–13. Size 7½ × 5, pp. (vol. 1) xiv. and 581; (vol. 2) viii. and 538; (vol. 3) x. and 598. *Price* 15*s.*

United Kingdom—Nottingham. **Mutschmann.**

The place-names of Nottinghamshire, their origin and development. By Heinrich Mutschmann. Cambridge: University Press, 1913. Size 9 × 5½, pp. xvi. and 179. *Price* 7*s.* 6*d. net. Presented by the Publishers.*

United Kingdom—Phytogeography. **Horwood.**

The story of plant life in the British Isles. Types of the common natural orders (Introductory volume). By A. R. Horwood. London: J. & A. Churchill, 1914. Size 8 × 5, pp. xiv. and 254. *Illustrations. Price* 6*s.* 6*d. net. Presented by the Publishers.*

ASIA.

Arabia. **Schmidt.**

Das südwestliche Arabien. Von Dr. Walther Schmidt. (Angewandte Geographie. Herausgeber, Dr. Hugo Grothe; IV. Serie, 8 Heft.) Frankfurt: H. Keller, 1913. Size 9 × 6, pp. viii. and 136. *Map. Price M.*3.60.

Asia—Ancient trade. *T'oung Pao* **14** (1913): 315–364. **Laufer.**

Arabic and Chinese trade in Walrus and Narwhal Ivory. By Berthold Laufer.

Asia—Historical. **Yule and Cordier.**

Cathay and the way thither, being a collection of mediæval notices of China. Translated and edited by Col. Sir Henry Yule . . . New edition, revised throughout in the light of recent discoveries by Henri Cordier. Vol. 2: Odoric of Pordenone. (Works issued by the Hakluyt Society, Second Series, No. 33.) London, 1913. Size 9 × 5¼, pp. xiii. and 267. *Map and Illustrations.*

The first volume, which will contain both Yule's and Cordier's introductions, will appear later. Prof. Cordier's editorial work has been very thorough.

China—Canton. *Tour du Monde* **19** (1913): 385–396. **Bel.**

La vie fluviale dans la région de Canton. Par Raymond Bel. *Sketch-map and Illustrations.*

China—Mongolia. *B.S.R. Belge G.* **37** (1913): 83–128, 153–184. **Verbrugge.**

Excursion en Mongolie. De Péking au plateau Mongol. De Ho-t'ou-wa à Lamamiao. Par le R. P. Dr. R. Verbrugge. *Sketch-maps and Diagrams.*

China—Tibet. *Missions Catholiques* **45** (1913): 249–252. **Desgodins.**

M. Desgodins et la Mission du Thibet. *Portrait.*

See notice in the December number, 1913, p. 579.

China, Western. **Wilson.**

A naturalist in Western China with vasculum, camera, and gun, being some account of eleven years' travel, exploration, and observation in the more remote parts of the Flowery Kingdom. By Ernest Henry Wilson. 2 vols. London: Methuen & Co., [1913]. Size 9 × 6, pp. (vol. 1) xxxvii. and 251; (vol. 2) xi. and 229. *Map and Illustrations. Price* 30*s. net.*

Dutch East Indies—Historical. **Bolling and Visscher.**

Bijdr. Taal-, Land- en Volk., Ned.-Indië **68** (1913): 291–381.

Friderici Bollingii, Oost-Indisch Reisboek . . . 1678. Uit het Deensch vertaald door Mej. Joh. Visscher. *Illustrations.*

India. **Meysey-Thompson.**

India of to-day. By E. C. Meysey-Thompson. London: Smith, Elder & Co., 1913. Size 9 × 5½, pp. vi. and 230. *Sketch-map. Price* 6*s. net. Presented by the Publishers.*

India—Himalaya. **Bairnsfather.**

Sport and nature in the Himalaya. By Lieut.-Col. P. R. Bairnsfather. London: Harrison & Sons, 1914. Size 8½ × 6½, pp. xv. and 137. *Illustrations. Price* 5*s. net. Presented by the Publishers.*

Malay States—Selangor. *J. Linnean S., Botany* **41** (1913): 285–304. **Ridley and Kloss.**

An expedition to Mount Mĕnuang Gasing, Selangor. By Henry N. Ridley; with an account of the journey by C. B. Kloss.

See note in the February number, p. 201.

Russia—Siberia. **Goebel.**

Vom Ural bis Sachalin. Von Otto Goebel. Berlin: D. Reimer, 1913. Size 9½ × 6½, pp. vi. and 166. *Price* 3*s.* 9*d.*

The writer's extensive travels (with the support of the German Foreign Office) have enabled him to speak with authority on the present position of the country.

Turkey—Palestine. **Graham.**

With the Russian pilgrims to Jerusalem. By Stephen Graham. London: Macmillan & Co., 1913. Size 9 × 5½, pp. x. and 306. *Sketch-maps and Illustrations. Price* 7*s.* 6*d. net.*

AFRICA.

Abyssinia. **Beccari.**

Rerum Æthiopicarum scriptores occidentales inediti a sæculo xvi. ad xix., curante C. Beccari. Vol. 13: Relationes et epistolæ variorum, Pars prima, Liber iv. Rome: C. de Luigi, 1913. Size 10½ × 7½, pp. xvii. and 492. *Facsimiles. Price* 20*s.* 8*d.*

Africa. **Letcher.**

The bonds of Africa: impressions of travel and sport from Cape Town to Cairo, 1902–1912. By Owen Letcher. London: John Long, Ltd., 1913. Size 9 × 5½, pp. 267. *Map and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

Belgian Congo—Railway. *Mouvement G.* **30** (1913): 343–348. **Wauters.**

Notre politique de chemins de fer au Congo et la voie de l'Urua. Par A. J. Wauters. *Sketch-maps.*

British East Africa—Zoogeography. **Heller.**

Smithsonian Misc. Coll. **61** (1913): No. 1, pp. 78.

The white rhinoceros. By Edmund Heller. *Illustrations.*

British West Africa. **Lucas and Keith.**

A historical geography of the British Colonies. By Sir C. P. Lucas. Vol. 3: West Africa. Third edition, revised . . . by A. Berriedale Keith. Oxford: Clarendon Press, 1913. Size 7½ × 5, pp. vi. and 427. *Maps. Price* 8*s.* 6*d. Presented by the Publishers.*

Cape Colony—Observatory. **Gill.**

A history and description of the Royal Observatory, Cape of Good Hope. By Sir David Gill. London: Published by the Admiralty, 1913. Size 15 × 11, pp. cxc. and 136. *Map, Plan, Illustrations, and Diagrams.*

Cape Colony—Orange river. *Nineteenth Century* **74** (1913): 643–655. **Macdonald.**

The cataracts of King George. By William Macdonald.

Cf. note in vol. **39**, p. 491.

Cape Verde Islands. **Friedlaender.**

Beiträge zur Kenntnis der Kapverdischen Inseln: die Ergebnisse einer Studienreise im Sommer 1912 von Immanuel Friedlaender. Berlin: D. Reimer, 1913. Size 10 × 8½, pp. xii. and 109. *Maps and Illustrations.* *Price* 15*s.*

An important addition to our knowledge of the group. The author is primarily a vulcanologist, but here discusses also the general geography of the islands.

Congo basin—Hydrology. *La G., B.S.G. Paris* **28** (1913): 73–94. **Roussilhe.**

Mission hydrographique Congo-Oubangui-Sanga. Par H. Roussilhe. *Sketch-maps, Illustrations, and Diagrams.*

See note in the February number, 1914, p. 204.

Egypt—Beheira—Map. *Cairo Sc. J.* **7** (1913): 170–176. **Clowes.**

The contoured map of Beheira Province. By G. S. Laird Clowes. *Maps and Diagrams.*

Egypt—Cotton. **Survey Department.**

Ministry of Finance, Egypt. Survey Department Paper, No. 31. The effect of water on the cultivation of cotton. Experiments made during 1912. Cairo, 1913. Size 10½ × 7, pp. 24. *Diagrams.*

Describes further experiments (cf. *Journal*, vol. **41**, p. 587).

Egypt—Historical. *Rendiconti R.A. Lincei (Sc. Morali)* **21** (1912): 3–68. **Schiaparelli.**

La geografia dell' Africa orientale, secondo le indicazioni dei monumenti egiziani. Da Ernesto Schiaparelli.

Egypt—Nile flood. **Survey Department.**

Ministry of Finance, Egypt, Survey Department Paper, No. 27. The rains of the Nile Basin and the Nile Flood of 1911. By J. I. Craig. Cairo, 1913. Size 10½ × 7, pp. 110. *Map and Diagrams.*

Egypt—Phosphate deposits. **Ball.**

Ministry of Finance, Egypt, Survey Department Paper No. 30. A brief note on the phosphate deposits of Egypt. By Dr. John Ball. Cairo, 1913. Size 10½ × 7, pp. 6. *Sketch-map.*

Equatorial Africa—Volcano. *M. Deuts. Schutzgeb.* **26** (1913): 159–163. **Schumacher.**

Der vulkanische Ausbruch im Norden des Kiwu-Sees vom 4. Dezember 1912 bis 2 Januar 1913. (Von Stabsarzt Dr. Schumacher.) *Sketch-map.*

French Equatorial Africa. **Audoin.**

Renseignements Col., Afrique française (1913): 177–238, 246–290.

La mission hydrographique du Gabon. Par Lieutenant de vaisseau Audoin. *Sketch-maps, Diagrams, and Illustrations.*

See note in vol. **41**, p. 387.

French West Africa—Chad Territory. **Lagrange.**

La G., B.S.G. Paris **28** (1913): 157–171.

La circonscription du Batha. Par Capitaine Lagrange.

French West Africa—Niger. *B.S.G. Com. Paris* **35** (1913): 569–587. **Chudeau.**

La zone d'inondation du Niger. Par R. Chudeau. *Sketch-map.*

South Africa. **Lucas and Keith.**

A historical geography of the British Colonies. Vol. **4**: South Africa. New edition. Part I.: History to 1895. By Sir Charles Lucas (pp. viii. and 331); Part II.: Geographical. Revised by A. Berriedale Keith (pp. iv. and 332). Oxford: Clarendon Press, 1913. Size 7½ × 5. *Maps.* *Price (each part)* **6***s.* **6***d.* *Presented by the Publishers.*

South Africa—Historical. **Cory.**

The rise of South Africa: a history of the origin of South African colonisation and of its development towards the East from the earliest times to 1857. By G. E. Cory. Vol. **2**: From 1820 to 1834. London: Longmans, Green & Co., 1913. Size 9½ × 6, pp. xvi. and 489. *Maps and Illustrations.* *Price* 18*s.*

Vol. 1 appeared in 1910.

South Africa—Names and Terms. **Pettman.**

Africanderisms: a glossary of South African colloquial words and phrases and of place and other names. Compiled by the Rev. Charles Pettman. London: Longmans, Green & Co., 1913. Size 9 × 6, pp. xvii. and 579. *Price* 12*s.* 6*d.*

A valuable guide to South African names and terms, evidently compiled with much care.

NORTH AMERICA.

Alaska—Geology. *U.S. Geol. Surv. B.* **535** (1913): pp. 38. **Eakin.**

A geologic reconnaissance of a part of the Rampart Quadrangle, Alaska. By Henry M. Eakin. *Maps and Illustrations.*

Alaska—Geology. *U.S. Geol. Surv. B.* **533** (1913): pp. 140. **Moffit.**

Geology of the Nome and Grand Central quadrangles, Alaska. By Fred H. Moffit. *Maps, Illustrations, and Sections.*

Alaska—Geology. *U.S. Geol. Surv. B.* **525** (1913): pp. 220. **Prindle and others.**

A geologic reconnaissance of the Fairbanks Quadrangle, Alaska. By L. M. Prindle, with a detailed description of the Fairbanks district. By L. M. Prindle and F. J. Katz, and an account of lode mining near Fairbanks by Philip S. Smith. *Maps, Illustrations, Sections, and Diagrams.*

Alaska—Glacial deposits. *J. Geology* **21** (1913): 289–300. **Tarr and Martin.**

Glacial deposits of the continental type in Alaska. By R. S. Tarr and Lawrence Martin. *Sketch-map and Illustrations.*

Alaska—Glaciers. *U.S. Geol. Surv. B.* **526** (1913): pp. 76. **Grant and Higgins.**

Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska. By U. S. Grant and D. F. Higgins. *Maps and Illustrations.*

Alaska—Mount McKinley. **Browne.**

The conquest of Mount McKinley, the story of three expeditions through the Alaskan wilderness to Mount McKinley, North America's highest and most inaccessible mountain. By Belmore Browne. New York and London: G. P. Putnam's Sons, 1913. Size 9 × 6, pp. xvii. and 381. *Maps and Illustrations. Price* 15*s. net.*

Alaska—Yukon basin. *U.S. Geol. Surv. B.* **532** (1913): pp. 120. **Maddren.**

The Koyukuk-Chandalar region, Alaska. By A. G. Maddren. *Maps and Illustrations.*

The Koyukuk and Chandalar are northern tributaries of the Yukon.

Canada—Vancouver. **Vrooman.**

Vancouver. The Pacific port of the Empire. By Dr. Frank Buffington Vrooman. Vancouver, B.C. [1913]. Size 9½ × 6, pp. 24.

North America—Historical. **Babcock.**

Early Norse visits to North America. By William H. Babcock. (Smithsonian Miscellaneous Collections, vol. 59, No. 19, 1913.) Washington, 1913 Size 10 × 6½, pp. 213. *Maps and Illustrations. Presented by the Author.*

Reviewed in the February number, p. 194.

CENTRAL AND SOUTH AMERICA.

America—Railways. *B.G.S. Philadelphia* **11** (1913): 209–223. **Schoff.**

Latin American railways, present and projected. By Wilfred H. Schoff. *Illustrations.*

Argentine. **Regel.**

Argentinien. Von Dr. Fritz Regel. (Angewandte Geographie. Herausgeber: Dr. Hugo Grothe; IV. Serie, 10 Heft.) Frankfurt: H. Keller, 1914. Size 9 × 6, pp. iv. and 178. *Maps, Plan, and Illustrations. Price M.*4.80.

Argentine Republic—Petroleum. **Bonarelli.**

An. S. Científica Argentina **76** (1913): 5–27.

Exploración de la región petrolifera de Salta. Por Doctor Guido Bonarelli. *Sketch-maps.*

Bolivia—Chaco. **Nino.**

Guia al Chaco Boliviano. Por Fr. Bernardino de Nino. La Paz, 1913. Size 9 × 6, pp. xviii. and 190. *Map.*

Bolivia—Ethnology. **Nino.**

Etnografia Chiriguana. Por el P. Fr. Bernardino de Nino. La Paz, 1912. Size 10 × 6½, pp. xxii. and 382. *Map and Illustrations.*

Brazil—Geology. *P. American Philos. S.* **52** (1913): 163–174. **Branner.**

The fluting and pitting of granites in the Tropics. By J. C. Branner. *Illustrations and Sections.*

Chile—Nitrate. *Popular Sc. Monthly* **83** (1913) : 209–230. **Tower.**
The Nitrate fields of Chile. By Dr. Walter S. Tower. *Sketch-map and Illustrations.*

Falkland Islands. *Colonial J.* **7** (1913): 15–31. **Roper.**
The Falkland Islands. By W. J. Roper.

Honduras—Commercial. *B.G.S. Philadelphia* **11** (1913): 224–239. **MacClintock.**
Resources and industries of Honduras. By Dr. Samuel MacClintock. *Illustrations.*

Panama. **Bunau-Varilla.**
Panama: the creation, destruction and resurrection. By Philippe Bunau-Varilla. London: Constable & Co., 1913. Size 10 × 6, pp. xx. and 568. *Illustrations, Sections, and Diagrams. Price* 12*s.* 6*d.*
The author, well known in connection with the early French canal project, still maintains the feasibility of a sea-level canal without locks.

Panama Canal. *Tour du Monde* **19** (1913) : 337–348. **De la Valette.**
Au Canal de Panama. Par Louis Baudin de la Valette. *Sketch-map and Illustrations.*

Panama Canal. *J.R.S. Arts* **61** (1913): 993–1008. **Taylor.**
The engineering aspect of the Panama Canal at the present time, 1913. By William T. Taylor. *Sketch-maps, Illustrations, and Diagrams.*

Panama Canal—Treaties. *P. American Philos. S.* **52** (1913) : 234–242. **Tower.**
The treaty obligations of the United States relating to the Panama Canal. By Charlemagne Tower.

South America. **Holland.**
To the River Plate and back, the narrative of a scientific mission to South America, with observations upon things seen and suggested. By W. J. Holland. New York and London: G. P. Putnam's Sons, 1913. Size 9½ × 6, pp. xiii. and 387. *Illustrations and Diagrams. Price* 15*s. net. Presented by the Publishers.*

South America. **Koebel.**
The making of the nations. South America. By W. H. Koebel. London: A. & C. Black, 1913. Size 8¼ × 5½, pp. x. and 298. *Portrait and Illustrations. Price* 7*s.* 6*d.*

South America—West Coast. **Peixotto.**
Pacific shores from Panama. By Ernest Peixotto. London: Bickers & Son, 1913. Size 9½ × 6½, pp. xiv. and 285. *Illustrations. Price* 10*s.* 6*d. net.*
A well-written account of a tour on the western side of America (mainly South America), likely to be useful to others contemplating such a trip.

AUSTRALASIA AND PACIFIC ISLANDS.

Easter Island. **Knoche.**
Observaciones meteorológicas de la Isla de Pascua. Algunas observaciones a la geomorfología de la Isla de Pascua. Por Walter Knoche. (From 'Publicacion No. 4 del Instituto Central Meteorológico de Chile, 1913.) [Santiago, 1913.] Size 15 × 10½, pp. 6. [In Spanish and German.]

Hawaii—Water resources. **Leighton and others.**
U.S. Geol. Surv. Water-supply Paper **318** (1913): pp. 552.
Water resources of Hawaii, 1909–1911. Prepared under the direction of M. O. Leighton by W. F. Martin and C. H. Pierce. *Maps and Illustrations.*

New South Wales—Quicksilver. **Carne.**
New South Wales. Department of Mines. Geological Survey. Mineral resources, No. 7. Mercury, or "Quicksilver," in New South Wales, with notes on its occurrence in other colonies and countries. By. J. E. Carne. 2nd edit. Sydney, 1913. Size 10 × 6, pp. 54. *Sketch-maps.*

Queensland—York Peninsula. *Queensland G.J.* **26–27**, 1910–1912 (1913): 38–49. **Dick**
From the Mein Telegraph Station, N.E., to Lloyd's Bay, and up the Lockhart river to its head. By J. Dick.

POLAR REGIONS.

Antarctic—Shackleton Expedition. **Shackleton.**

Shackleton in the Antarctic, being the story of the British Antarctic Expedition, 1907–1909. By Sir Ernest Shackleton. London: W. Heinemann, 1911. Size 7½ × 5, pp. 255. *Sketch-map and Illustrations.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. *B. Mount Weather Observatory* **6** (1913): 1–34. **Humphreys.**

Volcanic dust and other factors in the production of climatic changes, and their possible relation to ice ages. By W. J. Humphreys. *Diagrams.*

See note in the Monthly Record, *ante.*

Geomorphology. *J. Geology* **21** (1913): 268–272. **Keyes.**

Original streams, and their rôle in general desert leveling. By Charles R. Keyes.

Geomorphology. *B.S.G. l'Est* **34** (1913): 27–38. **Lallemand.**

La terre, sa forme et ses dimensions, ses accidents superficiels et son relief. Par Charles Lallemand.

Geomorphology—Limestones. **Arbenz.**

Neujahrsblatt Naturfors. Ges. Zürich **115** (1913): pp. 18.

Ueber Karrenbildungen. Von P. Arbenz. *Illustrations.*

Geophysics. **Bicchieri.**

Le più recenti cognizioni e ipotesi sulle condizioni dell' interno della terra. Por G. Ricchieri. (From the 'Miscellanea di Studi' publicata pel cinquantenario della R. Accademia Scientifica Letteraria di Milano, Dicembre, 1912.) Milan, 1912. Size 9½ × 6½, pp. 48.

Hydrology. *Queensland G.J.* **26–27**, 1910–1912 (1913): 1–14. **Phillips.**

On the loss of water due to evaporation, percolation, and absorption, with special reference to the Brisbane water-supply. By George Phillips. *Sketch-map.*

Kumatology. **Cornish.**

Waves of sand and snow and the eddies which make them. By Vaughan Cornish. London: T. Fisher Unwin, [1914]. Size 9 × 6, pp. 383. *Sketch-map, Illustrations, Sections, and Diagrams. Price 10s. net. Presented by the Publisher.*

Meteorology—Solar Radiation. *Met. Z.* **30** (1913): 257–261. **Abbot and others**

Die Solarkonstante und ihre Schwankungen. Von C. G. Abbot, F. E. Fowle und L. B. Aldrich. *Diagram.*

Meteorology—Solar radiation. **Abbot and others.**

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. 3. By C. G. Abbot, F. E. Fowle, and L. B. Aldrich. Washington, 1913. Size 13 × 9½, pp. viii. and 242. *Illustrations and Diagrams.*

Chiefly concerned with observations of solar radiation in California and Algeria (cf. *Journal*, vol. **42**, p. 83).

Seismology. **Walker.**

Modern seismology. By G. W. Walker. London: Longmans, Green, & Co., 1913. Size 9 × 6, pp. xii. and 188. *Illustrations and Diagrams. Price 5s.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography. **Collins.**

Permanence of geographical control over Man, with special reference to his finger impressions. By H. N. Warner Collins. (London, 1913.) Size 7 × 4½, pp. 4. *Diagrams.*

Anthropogeography—Monuments. **Fewkes.**

Smithsonian Misc. Coll. **61** (1913): No. 6, pp. 50.

Great stone monuments in history and geography. By J. Walter Fewkes. *Illustrations.*

Commerce. **Oppel.**

Der Welthandel: seine Entwicklung und gegenwärtige Gestaltung. Von Prof. Dr. A. Oppel. (Angewandte Geographie. Herausgeber: Dr. Hugo Grothe; IV. Serie, 9 Heft.) Frankfurt: H. Keller, 1914. Size 9 × 6, pp. 129. *Price M. 3.*

Commercial—Maize. **Burtt-Davy.**

Maize: its history, cultivation, handling, and uses, with special reference to South Africa. A text-book for farmers, students of agriculture, and teachers of nature study, by Joseph Burtt-Davy. London: Longmans, Green & Co., 1914. Size 9 × 6, pp. xl. and 831. *Illustrations. Price 25s. net. Presented by the Publishers.*

Historical—Travel. **Howard.**

English travellers of the Renaissance. By Clare Howard. London; John Lane, 1914. Size 9 × 6, pp. xvii. and 233. *Facsmile Illustrations. Price 7s. 6d. net. Presented by the Publishers.*

History of Cartography. *Fennia* **31** (1909–1911): 1–10. **Palmén.**

Simon van Salinghens Karta öfver Norden 1601. Af E. G. Palmén. *Map.* [In Swedish, German *résumé*.]

History of Cartography. **Pajares.**

Una carta náutica en la Biblioteca universitaria de Valencia. Por Ramón Velasco Pajares. (From *El Educador Contemporáneo*, Núm. 20, Septiembre de 1913.) Valencia, 1913. Size 10 × 6, pp. 231–235.

The map in question was the work of Jacobo Russo of Messina. It is dated 1563.

Meteorology—Temperature on mountains. *Met. Z.* **30** (1913): 278–289. **Ficker.**

Temperaturdifferenz zwischen freier Atmosphäre und Berggipfeln. Von H. v. Ficker. *Diagrams.*

Sociology. **Lewinski.**

The Origin of Property and the formation of the village community. A course of lectures delivered at the London School of Economics. By Jan St. Lewinski. London: Constable & Company, Ltd., 1913. Size 8½ × 5½, pp. xii. and 72. *Sketch-maps. Price 3s. 6d. net. Presented by the Publishers.*

BIOGRAPHY.

Agassiz. **Agassiz.**

Letters and recollections of Alexander Agassiz, with a sketch of his life and work. Edited by G. R. Agassiz. London: Constable & Co., 1913. Size 9 × 6, pp. xi. and 454. *Portraits, Maps, and Illustrations. Price 14s.*

GENERAL.

Geography—Text-book. **Franklin and Griffiths.**

The Atlas Geographics: a new visual atlas and geography combined. Part III.: Senior Geography. No. 4: Africa. By Thomas Franklin and E. D. Griffiths. London: W. & A. K. Johnston, [1914]. Size 10 × 7½, pp. iv. and 116. *Maps. Price 1s. 6d. net. Presented by the Publishers.*

This is the first part issued of the "Senior" geography, which will include, in separate volumes, the British Empire and each continent except Australia. In reference to the review of the "Junior" and "Physical" volumes in the February number, it should be mentioned that, although supplied separately at a penny each, the coloured orographical maps have been specially prepared for this series.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

Bavaria. **K.B. Generalstab, Munich.**

Der topographische Atlas von Bayern. Bearbeitet in dem topographischen Bureau des K. Bayer. Generalstabes. Scale 1: 50,000 or 1·3 inch to 1 stat. mile. Sheet 97, Mittenwald (Ost u. West). Munich: Theodor Riedel, 1912. *Price* 1.50 *M. each half-sheet.*

Two sheets of a map of Bavaria now in course of publication, of which seven sheets, or fourteen half-sheets, have already been issued. The sheets are in two halves,

east and west, and each of these measures 19¾ by 15¾ inches, and embraces about fourteen minutes of latitude and sixteen minutes of longitude. The map is based on the large-scale Government survey, and shows relief in contour-lines in reddish brown at 20-metre intervals, combined with rockwork in hachures of the same colour. In order to accentuate the relief shading in a darkish purple is superimposed, with a result that is not altogether satisfactory, inasmuch as it imparts to the whole a sombre and heavy appearance, which, apart from being unpleasing to the eye, in great measure tends to obliterate the detail of the map. These coloured sheets are printed from transfers from the plates, and it is possible to obtain them without the dark shading if preferred. Water is in blue, and the rest of the map in black. When complete the map will consist altogether of 224 half-sheets.

British Isles. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, from January 1 to 31, 1914.

England and Wales.

6-inch maps, revised:—

Lancashire, 55 N.W. **Sussex,** 51 N.W., N.E., S.W., 52 S.E. **Yorkshire,** 88 S.W. Quarter-sheets, with contours in blue. *Price* 1*s. each.* **Berkshire,** 12 N.E., 13 N.E., 16 N.W., 20 N.E., 22 N.W., 24 S.W., 28 S.E. **Denbigh,** 41 S.E. **Lancashire,** 44 N.W., S.E. **Oxford,** 49 N.W., 52 N.W., 55 S.E. **Sussex,** 11 S.E., 12 S.W., 23 S.W., 34 S.W., 35 N.E., 48 N.W., N.E., S.E., 49 N.W., N.E., 60 N.E., 62 N.E., 63 N.W., N.E. **Yorkshire,** 66 S.W., 74 N.W., with contours in red. *Price* 1*s. each.*

1 : 2500 scale maps:—

Stippled with areas. *Price* 3*s. each.*

Carnarvon, 8–11, **18**–3, 7, 11, 12, 15, **29**–7, 8. **Hertfordshire, 39**–13, 15, **41**–16, **43**–3, **44**–3, 4, 7, 10, **45**–5. **Lancashire, 4**–1, 11, **8**–11. **Merioneth, 4**–7. **Middlesex, 6**–5. **Norfolk, 63**–2. **Notts, 43**–1. **Surrey, 26**–2, 6. **Warwick, 17**–1, 2, 5, 6, 9, 13, **21**–11, 12, **28**–3. **Westmoreland, 47**–8, 11. Sheets **47**–15, **48**–6. *Price* 1*s.* 6*d. each.* **Yorkshire, 23**–7, 8, **24**–7, 11, **25**–12, 13, **27**–10, 11, 13, **38**–4, **40**–2, 3, **41**–2. **Yorkshire** (2nd revision), **248**–15.

Ireland.

1-inch map engraved in outline, with contours, sheet 42. *Price* 1*s.* 3rd edit. Engraved in outline, with contours, sheet 140. *Price* 1*s.*

Messrs. E. Stanford, Ltd., London Agents.

British Isles—London. **Cook and Hammond.**

Map of the railways of London and Suburbs, showing railways open, authorised and constructing, together with those proposed for session 1914. Scale 1 : 21,120 or 3 inches to 1 stat. mile. Size 36 by 50 inches. Compiled by Robt. J. Cook and Hammond. Westminster, 1914. *Price* 5*s.*

New edition of a useful map.

France. **Michelin.**

Carte Michelin. France en 47 Feuilles au 1 : 200,000 (1 inch to 3·15 stat. miles). Sheets: 27, Limoges; 34, Bordeaux; 35, Aurillac-Cahors; 38, Mont-de-Marsan; 39, Agen-Montauban; 42, Pau; 43, Toulouse; 46, Bagnères-de-Luchon; 47, Perpignan. Size 16 by 38 inches each. Paris: Ch. Delagrave, [1913]. *Price* 1.25 *fr. each sheet.*

Holland. **Beekman.**

Geschiedkundige Atlas van Nederland. Uitgegeven door de Commissie voor den Geschiedkundigen Atlas van Nederland en Geteekende door het lid der Commissie A. A. Beekman. De Republik in 1795. Sheets: 1, 3, 19, each 10 by 12 inches. The Hague: M. Nijhoff, 1913.

With the publication of these sheets this map of the Netherlands in 1795 is complete. A notice of the first part appeared in the *Geographical Journal* for April, 1912, and since then the sheets have appeared, three at a time, in portfolios at intervals of about six months. It is a map that cannot fail to be of interest to all students of the history of the country, and very properly appears as the first publication in the series of which this historical atlas of the Netherlands is to consist. Accompanying this part is an octavo book of 209 pages giving a full description of the map

and a revised reissue of sheet 15. There will be altogether sixteen other maps in the atlas, but none of them will consist of more than eight sheets.

Holland. **Geest.**

Het Koninkrijk der Nederlanden. Naar de Topografische Kaart (1 : 50,000) in andere nieuwe bronnen ontworpen en geteekend door E. de Geest. De Scheepvaartwergen door G. S. Vlieger. Scale 1 : 300,000 or 1 inch to 4·7 stat. miles. 2 sheets, each 20 by 35 inches. Amsterdam : Seyffardt's Boekhandel, 1913.

A good general map with canals shown in blue lines of different breadths and style by which the tonnage of the vessels which can pass through them can be readily ascertained. Roads, railways, and other information are given. The map is accompanied by an index to place-names as a separate pamphlet.

ASIA.

China. **Geographical Section, General Staff.**

Map of China, showing railways, telegraphs, and treaty ports. Scale 1 : 5,000,000 or 1 inch to 78·9 stat. miles. Size 22 by 26 inches. Compiled in the Geographical Section, General Staff, War Office, 1913. London agents : Edward Stanford, Ltd. ; Sifton, Praed & Co. ; T. Fisher Unwin. *Price* 1s. 8*d. net.*

A useful outline map showing in red, by different symbols, railways open to traffic, under construction, and projected ; and telegraph lines with stations in black. At the side of the map full particulars in tabular form are given concerning railways and railway construction in China at the present time. Amongst other important facts to be learned from this table is the class of railway, their gauge, mileage, how far they opened, all of which would be difficult to obtain elsewhere.

Indo-China. **Pavie.**

Indo-Chine. Carte de la Mission Pavie dressée sous les auspices du Ministre des Affairs Étrangères et du Ministre des Colonies sous la direction de M. Pavie par MM. les Capitaines Cupet, Friquegnon, De Malglaive et Seauve. Scale 1 : 2,000,000 or 1 inch to 31·56 stat. miles. Size 41 by 31 inches. Paris : Augustin Challamel, 1914.

A comparison with the previous edition of the map will show that extensive additions and corrections have been made, and parts that were only roughly sketched in are now shown more accurately in considerable detail. It is an effective and useful coloured map including the whole region from Bhamo to Hainan island and Talifu to Cochin China.

AFRICA.

Cape of Good Hope. **Geographical Section, General Staff.**

Africa. Scale 1 : 250,000 or 1 inch to 3·95 stat. miles. Sheets : South H 34–D, Upington ; South H 34–Q, Carnarvon ; South H 34–X, Victoria West. Each sheet 19 by 17 inches. Drawn and printed at the War Office, 1913. London Agents : E. Stanford, Ltd. ; Sifton, Praed & Co. ; T. Fisher Unwin. *Price* 1s. 6*d. net each sheet. Presented by the Director of Military Operations.*

French West Africa. **Service Géographique des Colonies, Paris.**

Côte d'Ivoire. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheets : 4 D, 2 E, 3 E, 4 E, 1 F, 2 F, 3 F, 4 F, 1 G, 2 G. Each 18 by 26 inches. Paris : Librarie Colonial, [1914]. *Presented by M. A. Meunier, Paris.*

Eight sheets of a somewhat roughly executed map compiled from the information and route traverses of French officers. It is printed in colours, and shows relief by horizontal form lines in black. The sheets are undated, and nothing is stated as to the material used in their preparation.

German East Africa. **Trotha.**

Garnison Umgebungs-Karte von Massoko. Aufgenommen, konstruiert und gezeichnet von Hauptmann v. Trotha. Reduziert nach den Originalaufnahmen in 1 : 35,000 (1·8 inch to 1 stat. mile) v. W. Bobzin auf 1 : 100,000 (1 inch to 1·6 stat. mile) im Kartogr. Institut v. Dietrich Reimer (Ernst Vohsen), Berlin. Size 24 by 23 inches. *Mitteilungen aus den deutschen Schutzgebieten*, Band XXVI., 1913, Karte 11. Berlin : E. S. Mittler & Sohn, 1913. *Presented by Dietrich Reimer (Ernst Vohsen), Berlin.*

A well-executed coloured map of a district situated immediately to the north-west

of Lake Nyasa and adjacent to the Anglo-German boundary between that lake and Tanganyika. In addition to the general features, forest limits and other information are shown by tints of colour. The map accompanies an article in the above-mentioned publication.

German South-West Africa. **Kuntz.**

Geologische Uebersichtskarte des Kaokofelds (Deutsch-Südwestafrika) von J. Kuntz. Gedruckt auf Kosten der South-West Africa Comp., Ltd., als Beilage zu dem Aufsatze von Dr. Ing. C. Krause. Scale 1 : 800,000 or 1 inch to 12·6 stat. miles. Size 32 by 22 inches. *Zeitschrift für praktsiche Geologie*, 1913. Berlin: J. Springer, 1913. *Presented by Dietrich Reimer (Ernst Vohsen), Berlin.*

German South-West Africa. **Reuning.**

Karte des Küstengebietes zwischen Hottentottenbucht und Empfängnisbucht. [Von Dr. E. Reuning.] Scale 1 : 400,000 or 1 inch to 6·3 stat. miles. Size 26 by 6 inches. From *Mitteilungen aus den deutschen Schutzgebieten*, Band XXVI., 1913. Berlin: E. S. Mittler & Sohn, 1913. *Presented by Dietrich Reimer (Ernst Vohsen), Berlin.*

German West Africa. **Moisel.**

Höhenschichtenkarte von Kamerun mit Togo. Bearbeitet von Max Moisel. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. Size 32 by 24 inches. *Mitteilungen aus den Schutzgebieten*, Band XXVI, 1913, Karte 10. Berlin: E. S. Mittler & Sohn, 1913. *Presented by Dietrich Reimer (Ernst Vohsen), Berlin.*

This is a most interesting and instructive map, exhibiting effectively the general relief of this part of Africa on the layer system. For some years past German officers and travellers have been exploring the Kamerun and Togo, and from their route traverses, combined with the more exact surveys of boundary commissions and other sources of information, a general knowledge of the relief has been obtained, and this is now clearly brought out on this map; although a great deal must still be based on very approximate data. On the map of Kamerun the contour intervals in metres are 0–250, 250–500, 500–750, 750–1000, 1000–1500, 1500–2000, 2000–2500, 2500–3000, 3000–4000 and over 4000. The map of Togo is given as an inset, and the contour intervals for this are 0–100, 100–250, 250–500, 500–750, 750–1000 and over 1000. Sea-depths are shown in shades of blue at the same intervals as the height of land, except for the deepest water. A striking feature which this map brings out clearly is the continuation of the high land from Fernando Po island through Kamerun mountain and the mountainous region in the same north-easterly direction parallel with the Kamerun-Nigeria boundary. This map accompanies an account of this boundary region in the *Mitteilungen aus den Deutschen Schutzgebieten*, Band XXVI. Heft 4, which also contains an interesting note on the construction of the map by Herr M. Moisel.

Tunis. **Service Géographique de l'Armée, Paris.**

Carte de la Tunisie. Scale 1 : 100,000 or 1 inch to 1·6 stat. miles. Sheets: LXXXVII., Gara Kbira; LXXXVIII., Jarsine; XCV., Redjem Maatoug; CXXIV., Bir Oum Souirh. Size, each sheet, 13 by 20 inches. Paris: Service Géographique de l'Armée, 1913. *Price 1.20 fr. each sheet.*

Nos. LXXXVII., LXXXVIII., and XCV. show the southern shores of the Shott el Jerid and the adjacent desert country, and CXXIV. comes to the south-east of this district. Contours are given at 25-metre intervals.

Union of South Africa. **Mines Dept., Geological Survey.**

Geological Map of the Union of South Africa. Scale 1 : 150,000 or 1 inch to 1·3 stat. miles. Sheet 2, Pienaars River (new series), with Explanation. Size 16 by 28 inches. Pretoria: Mines Department, Geological Survey, 1913. *Presented by the Geological Survey of the Union of South Africa.*

Wadai. **Largeau.**

Carte du Ouadaï dressée sous la direction du Colonel Largeau, Commandant le Territoire Militaire du Tchad à l'aide des documents des Officiers du Territoire appuyés sur 26 positions astronomique. Scale 1 : 500,000 or 1 inch to 7·89 stat. miles. 2 sheets, each 21 by 32 inches. Paris: Service Géographique des Colonies, 1913. *Presented by the Ministère des Colonies, Paris.*

Although a great deal of this region is still unexplored, it will be seen from this map that the French officers have already done a considerable amount of route

traversing and compass sketching. This work has been brought together by Colonel Largeau, and adjusted to positions determined astronomically, of which the number is stated to be twenty-six. It would, however, have been an advantage if these had been clearly indicated on the map, and if more complete information had been given as to the material from which the map has been compiled.

West Africa. **Detzner and Moisel.**

Karte des Triangulationsnetzes der yola-Crossschnellen-Grenzexpedition (1907–1909) mit der Eintragung der 1912 vermarkten Grenze. [Von Oberleutnant Detzner.] Scale 1 : 1,000,000 or inch to 15·8 stat. miles. Size 15 by 16 inches. *Mitteilungen aus den deutschen Schutzgebieten*, Band XXVI., 1913, Tafel 2.—Uebersichtskarte der deutschen Grenze zwischen Yola und den Crossschnellen bearbeitet von M. Moisel. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. Size 15 by 14 inches. *Mitteilungen aus den deutschen Schutzgebieten*, Band XXVI., 1913, Karte 9. Berlin: E. S. Mittler & Sohn, 1913. *Presented by Dietrich Reimer (Ernst Vohsen), Berlin.*

AMERICA AND WEST INDIES.

Canada. **Dept. of the Interior, Ottawa.**

Sectional map of Canada. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Sheet 122, Manitoba House, Manitoba, revised to November 1, 1913. Size 18 by 31 inches. Ottawa: Department of the Interior, Topographical Surveys Branch, 1913. *Presented by the Department of the Interior, Ottawa.*

Canada. **Dept. of Mines, Geological Survey.**

Geological Survey of Canada. Map 65 B, Coast and Islands between Strait of Georgia and Queen Charlotte Sound, B.C., scale 1 : 253,440 or 1 inch to 4 stat. miles; 95 A, Broadback River, Mistassini Territory, Quebec, scale 1 : 633,600 or 1 inch to 10 stat. miles; 96 A, Wanipigon, Manigotagan and Oiseau Rivers, Manitoba, scale 1 : 253,140 or 1 inch to 4 stat. miles; 100 A, Bell River, Quebec, scale 1 : 506,380 or 1 inch to 8 stat. miles; 103 A, Southfork Coal Area, Old Man River, Alberta, scale 1 : 190,080 or 1 inch to 3 stat. miles; 104 A, Thompson River Valley below Kamloops Lake, B.C., scale 1 : 253,440 or 1 inch to 4 stat. miles; 105 A, Cadwallader Creek Mining Area, Lillooet Mining Division, B.C., scale 1 : 24,000 or 2·64 inches to 1 stat. mile; Groundhog Coal Field, B.C., scale 1 : 253,440 or 1 inch to 4 stat. miles; 107 A, Blairmore, Alberta, scale 1 : 126,720 or 1 inch to 2 stat. miles. Ottawa: Department of Mines, Geological Survey, 1913. *Presented by the Department of Mines, Geological Survey, Ottawa.*

Canada—Alberta. **Dept. of the Interior, Ottawa.**

Southern Alberta. Scale 1 : 792,000 or 1 inch to 12·5 stat. miles. Map showing disposition of Lands. Prepared in the Railway Lands Branch, F. C. C. Lynch, Superintendent. Corrected to January 1, 1910. 11th edit. Size 38 by 34 inches. Ottawa: Department of the Interior, 1913. *Presented by the Honourable J. Domville, Ottawa.*

Shows, by means of various colours and symbols: (1) lands finally disposed of (including school lands); (2) lands entered for, sold, or reserved previous to 1912 (unpatented); (3) lands entered for or reserved during 1912 (unpatented); (4) Indian Reserves; (5) Indian Reserves surrendered and sold; (6) timber berths; (7) forest reserves; (8) grazing leases; (9) boundaries of Dominion Lands' Agencies; (10) Dominion Lands' Offices; (11) boundary of Pre-emption tract.

Canada—British Columbia. **Dept. of the Interior, Ottawa.**

British Columbia Railway Belt. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Map showing disposition of lands, prepared under the direction of F. C. C. Lynch, Superintendent of Railway Lands. Corrected to September, 1913. Donald Sheet. Size 26 by 30 inches. Ottawa: Department of the Interior, 1913. *Presented by the Honourable J. Domville, Ottawa.*

This sheet shows the line of the Canadian-Pacific Railway, with the country on either side from Laggan, over the Kicking Horse pass, down to the Illecillewaet river. By means of different colours are clearly indicated: (1) homesteads patented and homesteads entered for and unpatented; (2) sales, special grants, mining lands sales; (3) lands disposed of by the Provincial Government; (4) forest reserves; (5) timber berths; (6) grazing leases; (7) Dominion Parks. In addition to this, trails, heights, post-offices, and other information are given.

Dutch West Indies—Aruba. **Topographical Bureau, The Hague.**

Topographische Kaart van Aruba. Scale 1 : 20,000 or 3·1 inches to 1 stat. mile. 8 sheets, each 16 by 16 inches. The Hague: Topographical Bureau, [1913].

Aruba is a small island in the West Indies belonging to the Dutch, situated about 50 miles to the west of Curaçao. This map is based upon a regular triangulation, and is most complete in every respect. Relief is shown by brown contours, the 5-, 10-, and 50-metre lines being distinguished by different symbols.

ATLANTIC OCEAN AND ISLANDS.

Cape Verde islands. **Friedlaender.**

Geologische Kartenskizze der Kapverdischen Inseln, 1 : 1,000,000 (1 inch to 15·78 stat. miles); Ilheus do Rombo, 1 . 100,000 (1 inch to 1·6 stat mile); Brava, 1: 100,000; Illa do Fogo, 1 : 100,000; Ilha de S. Thiago, 1 : 200,000 (1 inch to 3·15 stat. miles); Ilha do Maio, 1 : 200,000; Ilha de Boavista, 1,200,000; Ilha do Sal, 1 : 200,000: Ilha de S. Nicolao, 1 : 200,000; São Vicente, 1 : 100,000; Santa Luzia, Branco und Razo, 1 : 100,000; Santo Antão, 1 : 200,000. From *Immanuel Friedlaender's Beiträge zur Kenntnis der Kapverdischen Inseln.* Berlin: Dietrich Reimer (Ernst Vohsen), 1913.

A set of plans of the islands with contours at 50- and 100-metre intervals. The relief is further shown by neutral tint shading, which, though effective to a certain extent, gives an unnecessary dark and heavy appearance, which might have been obviated by using a lighter tint. The plans are accompanied by vertical sections and a general geological chart of the group. They vary in size from 9 by 7 inches to 15 by 14 inches.

GENERAL.

World. **Bartholomew.**

The Comparative Atlas, Physical and Political. By J. G. Bartholomew, LL.D., F.R.G.S. Eleventh edition, revised and improved. London: Meiklejohn & Son, Ltd., [1913]. *Price 2s. 6d.*

A new edition of a well-known quarto school atlas, containing sixty-four sheets of maps and an index to place-names. The maps, many of which are arranged in pairs, physical and political, have been generally revised and brought up to date. The physical maps show relief on the layer system in colour tints, and although open to improvement in some respects, they are far more satisfactory than is often the case with such atlases.

World. **Herbertson.**

The Oxford Wall Maps. Edited by A. J. Herbertson. The World, equatorial scale 1 : 33,300,000 or 1 inch to 525·5 stat. miles. 1, Physical Features without names; 2, Structure; 3, Political; 4, Mean Annual Rainfall; 5, Vegetation; 6, Thermal Regions; 7, Pressure and Winds; 8, Natural Regions. Oxford and London: The Clarendon Press. *Presented by the Publishers.*

These Oxford Wall Maps are now deservedly well known, and becoming increasingly appreciated for educational purposes, for which they are specially designed. The present World Series consists of a set of eight maps, or rather sheets of maps, drawn under the direction of Prof. A. J. Herbertson, to illustrate the distribution of natural phenomena throughout the world; and the subjects dealt with will be seen from the titles given above. They are bold in outline, not obliterated by unnecessary detail, and clearly printed in colours, the selection of which has evidently been made with care. The projection of the principal map on each sheet is Mollweide's equal-area; but as this is not suitable for showing regions in high latitudes, there are supplementary maps generally projected from the poles on Lambert's azimuthal equal-area projection. The equatorial scale of the principal map is 1 : 33,300,000, except in the case of No. 7, Pressure and Winds for January and July, which consists of two similar Mollweide projection maps on the equatorial scale of 1 : 44,400,000 and supplementary polar maps. The sheets are all of one size, 39½ inches by 59½ inches, and are mounted on linen with eyelet holes for hanging. The work of preparing such a series of maps has necessarily been very considerable, especially as they are the result of original research and compilation from the latest authorities, and it would be unreasonable to expect that they should be entirely beyond criticism. Various opinions have been expressed on some features of the Natural Regions map, No. 8, and indeed this map gave rise to a most interesting discussion at the last meeting of the British Association. There are other points that might be referred to, and the colouring of some of the maps is perhaps open to improvement. It would certainly be a great advantage if some better method could be found for colouring the rainfall maps, for the change from yellow to blue is

far from satisfactory, and suggests an abrupt and sudden change that does not exist in the rainfall itself. However, these matters can be dealt with in later editions if it is considered well to do so; and it is now fully recognized that this is a most useful series of maps, and Prof. Herbertson has certainly rendered great service to geographical education by their publication.

World. **Johnston.**

Johnston's New Area School Atlas. Edinburgh and London: W. & A. K. Johnston, Ltd., [1914]. *Price 6d. Presented by the Publishers.*

A cheap school atlas, measuring 10 by 7½ inches, containing forty maps, some of which are coloured to show relief on the larger system, and, with certain exceptions, fairly good, while some of the others, politically coloured, are poor productions. The physical map of England is misleading, since the first tint shows all land from sea-level to 500 feet in altitude, with the result that ranges, such as the North and South Downs, are represented only by a few isolated hilltops.

World. **Muir and Philip.**

Philips' Wall Atlas of Modern History. Edited by Prof. Ramsay Muir, M.A., and George Philip, F.R.G.S. 8 maps, each 33 by 43 inches. London: George Philip & Son, Ltd., 1914. *Price of set of 8 maps, 37s. 6d. Presented by the Publishers.*

A series of eight wall maps, measuring 46 by 36 inches, mounted on linen, and suitable for class-room use. They have been specially designed to illustrate those great changes in political geography which may be considered the main periods in the modern history of Europe. To prevent overcrowding, care has been taken to insert only those names which are likely to be useful to the student. The maps have been specially designed to supplement those given in the School and Students' editions of Philips' New Historical Atlas, edited by Prof. Ramsay Muir, and for this purpose should be valuable. Except in the case of Roman Britain, no attempt has been made to show mountains, and the absence of these certainly gives greater clearness to the maps; although, considering the important place they have taken in the development of history, it may perhaps be questioned whether the main ranges and passes should not have been indicated in some suitable way, even if it had been considered necessary to have separate maps as insets for the purpose. The following is a list of the maps:—

1, Europe, about 800 A.D.; 2, Roman Britain, Anglo-Saxon England; 3, Europe in the age of the Crusades; 4, Mediæval England and Wales, with part of Scotland, England in France; 5, Europe at the time of the Reformation; 6, North-Western Europe, seventeenth and eighteenth centuries; 7, Europe under Napoleon, 1810; 8, England in 1700, England in 1911.

World. **Philip.**

Philips' Modern School Atlas of Comparative Geography. New and enlarged edition. Edited by George Philip, F.R.G.S. London: George Philip & Son, Ltd., 1913.

This atlas contains eighty sheets of maps, plans, and diagrams, with an index to place-names. In addition to the general maps, many of which show relief on the layer tinting style, there are meteorological maps, maps showing density of population, vegetation, and others of the kind that are now often given in school atlases. As to merit they vary considerably, but many of them are much too crudely and highly coloured, and too confused for educational purposes.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, from January 4 to 31, 1914. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 11, Gnomonic chart for facilitating Great Circle sailing—North Atlantic, 2*s.* 18, Gnomonic chart for facilitating Great Circle sailing—South Atlantic, 2*s.* 132, Gnomonic chart for facilitating Great Circle sailing—Indian ocean, 2*s.* 3497, England, east coast: River Humber—Thorngumbald lights to Barton haven, including Hull road, 4*s.* 1461, Mediterranean: Italy—Approaches to Genoa (Plan: Genoa), 3*s.* **New Editions**—3778–3780, Telegraph chart of the World, showing submarine cables, principal land lines, and wireless telegraph stations open for commercial purposes—sheets 1–3, 4*s. each.* 1834, England, east coast: River Medway—Sheet 2: Bishops ness to Rochester, 3*s.* 2129, Ireland, south coast: Long Island and Baltimore bays, 3*s.* 2372, Baltic, Russian coast: Libau to Lyser ort, 4*s.* 2227, Gulf of Finland: Revel roadstead (Plan: Revel harbours), 2*s.* 1770, Baltic sea, Russia: Port of Libau (Plan added: Windau), 2*s.* 2148, France, north coast: Cayeux to Boulogne, 3*s.* 2744, France, north coast:

The channels and road of Morlaix, 3*s*. 86, Spain, west coast: Cadiz bay and approaches (Plan: Cadiz harbour), 3*s*. 1762, Greece, Ionian islands: Zante bay, 2*s*. 27, Persian gulf: Abu Shahr (Bushire), 3*s*. 2562, China: Canton river (Chu kiang) with its western branches to Sam shui, and adjacent country (Plans: Nam sha bay, Boddam cove, Sheung lung (Stone Dragon) rock), 4*s*. 2650, Russian Tartary: Strait of Tartary, and the entrance of the Amur river, 3*s*. 101, Japan, Nipon: Plans of anchorages in Rikuoku gulf: Kominato bay, Aomori anchorage, Nohechi (Nofitsi) anchorage (Plan of Port Ominato on this sheet erased) (Plan added: Moura kō fukin), 2*s*. 938, New Guinea: East cape to Cape Nelson, with the D'Entrecasteaux islands, 3*s*. 1757, Fiji islands, Viti Levu: Nukulau island to Namuka island, including Lauthala, Suva, and Namuka harbours, 3*s*. 2363, Pacific ocean, Friendly islands: Tongatábu, 4*s*. 1922, British Columbia: Fraser river and Burrard inlet, 4*s*. 540, Brazil: Bahia de Todos os Santos, 3*s*.

(*J. D. Potter, Agent.*)

Atlantic, North. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic Ocean, January, 1914. Washington: U.S. Hydrographic Office, 1913. *Presented by the U.S. Hydrographic Office.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly Meteorological charts of the North Atlantic and Mediterranean, February, 1914. London: Meteorological Office, 1914. *Price 6d. each. Presented by the Meteorological Office.*

French Equatorial Africa. **Mission Hydrographique du Gabon**

Côte Ouest d'Afrique. Lagune N'Komi ou de Fernan Vaz et ses abords d'après les reconnaissances effectuées de Septembre 1911 à Janvier 1912, echelle 1 : 100,000 (1 inch to 1·6 stat. mile); Bas-Ogooué d'après les reconnaissances effectuées d'Août à Décembre 1911, echelle 1 : 100,000 (1 inch to 1·6 stat. mile); Bas-Ogooué depuis le confluence de la Ngunié jusqu'à l'embouchure de l'Obando, d'après les reconnaissances effectuées d'Août à Novembre 1911, echelle 1 : 100,000 (1 inch to 1·6 stat. mile); Lagunes Simba, Sunga et N'Gobé ou d'Iguela, Rembo N'Gobé, d'après les reconnaissances effectuées d'Août à Décembre 1911, echelle 1 : 100,000 (1 inch to 1·6 stat. mile). Par ordre de M. Martial Merlin, Gouverneur-Général de l'Afrique Equatoriale Française par les Membres de la Mission Hydrographique du Gabon et d'aprés les travaux autérieurs. Paris: [Millet Fils, 1914]. *Presented by the Publishers.*

Indian Ocean. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean, February, 1914. London: Meteorological Office, 1914. *Price 6d. each. Presented by the Meteorological Office.*

Indian Ocean. **U.S. Hydrographic Office.**

Pilot chart of the Indian Ocean, March, 1914. Washington: U.S. Hydrographic Office, 1914. *Presented by the U.S. Hydrographic Office.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, March, 1914. Washington: U.S. Hydrographic Office, 1914. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

Australia. **Howard and Shearsby.**

Twenty-eight photographs of the Federal Capital Territory, Australia, taken by Messrs. Howard and Shearsby, of Yass. 1913. *Presented by R. Scrivener, Esq., and Griffith Taylor, Esq.*

These photographs were shown as lantern slides recently when Mr. Griffith Taylor read his paper before the Society. They form an important set, and give an excellent idea of the site of the capital. In years to come they will be of considerable historical interest. The sizes are 6 by 8 inches, and 4¼ by 6 inches. Several of the larger are joined together as panoramas.

(1) Canberra from Black mountain (2) Federal Capital, ceremonial; (3) Mr. O'Malley driving the first peg; (4) Watching the surveyor determining the second peg. (5) Administrative offices; (6) Residential tents occupied by Colonel Miller at Acton; (7) The administrator's residence; (8) Public Works office and Commonwealth bank; (9) Single draughtsmen's quarters, Acton; (10) Workmen's quarters, Acton; (11) Power house; (12) Acton nursery; (13) The camp, Cotter river; (14 and 15) Site of dam, Cotter river; (16) Preparing for foundations of dam, Cotter river; (17) Diversion channel, Cotter river dam; (18) The Coffer dam, Cotter river; (19) View near tunnel;

Cotter river; (20) Cotter river gorge; (21) Bridge piers, Murrumbidgee river; (22) Bridge over Molonglo river at Acton; (23) Royal Military college, Duntroon; (24) Cadets in marching kit, Duntroon Military college; (25) Cadets in horse parade, Duntroon Military college; (26) Rifle range, Duntroon Military college; Cadets doing physical training, Duntroon Military college; (28) Duntroon station homestead.

China. **Destelan.**

Seventeen photographs of southern China, taken by M. H. P. Destelan, Esq., 1909–1910. *Presented by M. H. P. Destelan, Esq.*

These photographs are of various sizes. The views of the west river are specially good.

(1) Procession at Shakee, Canton; (2) Shekmoon, Canton; (3) Passenger junk, Canton delta; (4) Patrol of the Canton river by British torpedo boats; (5 and 6) West river; (7) Monks at Ting-Wu-Shan temple, Howlik, West river; (8) Monk's head, West river; (9) Dosing, West river; (10) Wu-chou; (11) Foreign quarter, Wu-chou; (12) Upper reach, West river, from the British Consulate, Wu-chou; (13) West river above Wu-chou; (14) Entrance of the Hsin Hing gorges, West river; (15) The Hsin Hing gorges, West river; (16) Passage of the Yang-tzŭ at Shemite; (17) Robber condemned to death by strangulation at Chêng-tu.

Peru. **Corry.**

Twenty-eight photographs of Peru, taken by F. A. Corry, Esq., 1910–1913. *Presented by F. A. Corry, Esq.*

Fourteen of these photographs measure 4¼ by 6¾ inches, and sixteen are panoramas measuring 3¼ by 11½ inches. Among the more interesting may be mentioned the views of Cuzco, while the others are decidedly characteristic of the country.

(1) The Bay of Mollendo; (2 and 3) Port of Mollendo; (4) Mejia; (5) V. Charchani, V. Misti, and Arequipa from the railway bridge; (6) V. Misti and V. Charchani from Sumbay Alto; (7) Cloud of dust just rising at foot of Misti and Charchani after earthquake of August 6, 1913; (8) Lake Saracocha; (9) Puno and Puno bay, Lake Titicaca; (10) Copacabana bay, Lake Titicaca; (11) Copacabana; (12) Moho bay, Lake Titicaca; (13 and 14) Views from near La Raya; (15) From near La Raya, looking towards glacier on Vilcanota; (16) From foot of glacier on Vilcanota, looking towards La Raya; (17) At foot of glacier on Vilcanota; (18) Near Aguas Calientes; (19) Combapata valley; (20) Colque-Cruz and Lake Sinquerina; (21) San Sebastian; (22) San Geronimo; (23) Rainbow, San Geronimo; (24 and 25) Cuzco; (26) Suspension bridge, Rio San Gaban; (27) Chunchos and others, Inambari river; (28) A Chuncho in Inambari river.

Tahiti. **Corney.**

Photograph of Captain Cook's observation mark at Matavai (Point Venus), Tahiti, taken by B. Glanvill Corney, Esq., M.R.C.S., I.S.O., 1909. *Presented by B. Granville Corney, Esq., M.R.C.S., I.S.O.*

In 1901 the Royal Society and the Royal Geographical Society undertook to restore the memorial erected by Captain Cook in Tahiti, after the observation of the transit of Venus in 1769, which was falling into decay. This was done, the memorial fenced round, and a suitable tablet placed upon it. In 1909 Mr. Corney visited the spot and took a photograph of the memorial, and he has now been good enough to present an enlargement of his photograph to the Society.

United States. **Appleton.**

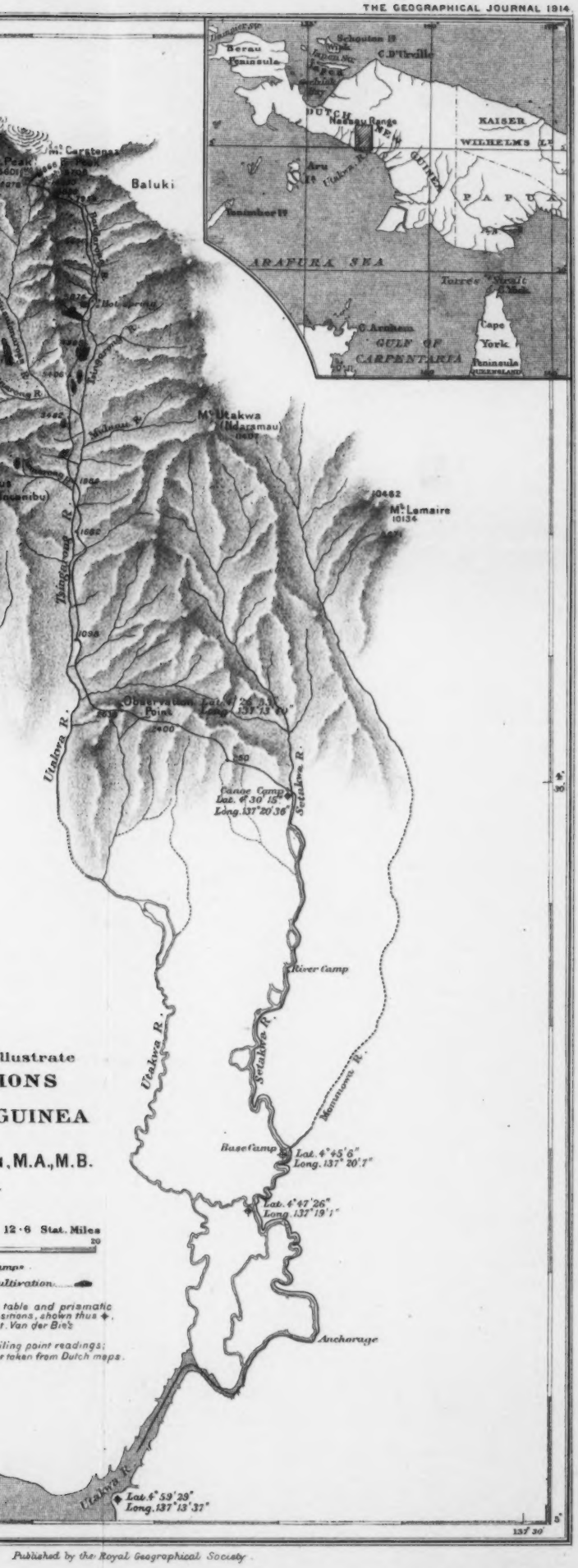
Twelve photographs of the Olympic mountains, Washington, taken by Colonel H. Appleton, R.E. *Presented by Colonel H. Appleton, R.E.*

These photographs were taken between the levels 5000 feet and 7000 feet on and about the divide above the Solduc Flor springs. They measure 3 by 3 inches, and give a good idea of this delightful district.

(1) A mountain lake at 5000 feet; (2) By the margin of the lake; (3) Mount Olympus, from a peak on the divide; (4) View south-east along the divide; (5) View east; (6–8) Mountain tarns; (9) View showing the main Solduc valley in the distance; (10) Mount Olympus; (11) Flowers at 5500 feet; (12) Flowers at 7000 feet.

N.B.—It would greatly add to the value of the collection of Photographs which have been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

137°
4°
Toraja
Mt Cockscomb
9235
Mt Venus
(Idenburg)
8°
30'
Sketch Map to illustra
EXPLORATIONS
IN
DUTCH NEW GUIN
by
A.F.R.WOLLASTON, M.A.,
1912-13.
Scale 1: 800,000 or 1 inch = 12·6 St
3 0 10
Route
Camps
Heights in feet.
Cultivation
This map is from the author's plane table and
compass traverses, adjusted to positions, sho
determined astronomically by Capt. Van der B
Expedition, 1910.
Heights along the route are from boiling point
others are from clinometer angles, or taken from
Eugera Pidwa R.
Idabuka R.
5°
137°
Published



llustrate
IONS
GUINEA
, M.A., M.B.

tables and prismatic
ssmans, shown thus ✦.
r. Van der Brez

iling point readings;
e taken from Dutch maps.

Published by the Royal Geographical Society.

DUTCH NEW GUINEA.
WOLLASTON.